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ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By ARTHUR THOMSON, M.A., M.D.

I.—COLOUR.

ONE of the most interesting, as well as one of the most difficult, problems with which we are brought face to face in the study of man is the question of colour. At first sight nothing makes so strong an impression on us as the distinctive colours of the races with which we are brought in contact. Hardly any other subject within the domains of physical anthropology has attracted so much attention, yet in spite of many ingenious theories and speculations as to its origin and the mode of its production, we are confessedly very ignorant of its true nature and significance. Whilst some would have us believe that primitive man was fair complexioned, there seems no less cogent reasons for maintaining that his skin was of a darker tint. It is not necessary for us to accept the extreme position, and thereby assume that he was black. A middle course is open, as suggested by Dr. A. R. Wallace, who advances the view that primitive man was probably of mongoloid stock, and that his subsequent modification into the white, and brown, and black varieties was due to his migrations into geographical areas, where he was subjected to the influence of varied conditions and climates. Whilst not committing ourselves to the acceptance of any such opinion with regard to the colour of our primitive stock, the theory propounded is suggestive, because it implies that colouration in man depends on the disposition of a common pigment or pigments in varying amount, and enables us to realise that the transition from fair to dark is a gradual one, and therefore possibly produced by the organism reacting to the influence of its environment. Throughout the literature of the subject there are a vast number of so-called facts, but unfortunately in many instances the information supplied is rendered valueless because insufficient data have been supplied to enable us to form a correct estimate of, or draw definite conclusions from, these observations.

Our intention in the present article is rather to draw attention to those associated details which seem to us of importance in studying the question, rather than to enter into a discussion of the theories advanced to account for the presence or absence of pigment in the skin of man. Before doing so, however, it may be well to state briefly what is known of the anatomical distribution of this pigment. Confining our attention more or less to its presence in the skin, we must refer shortly to the structure of the integument.

The *cutis vera*, or true skin, of mesoblastic origin, is a felted layer, of more or less compact tissue, abundantly provided with vessels and nerves. Superposed on this, and filling up the many irregularities of its surface, is an epithelial layer of epiblastic origin—the epidermis, cuticle, or scarf skin. The thickness of this layer varies considerably in different parts of the body, but in all cases we are able to distinguish a difference between the character of its deep and superficial cells. The former are polyhedral, large, and juicy, and are separated from each other by a series of intercellular channels; this layer constitutes the *stratum mucosum* of *Malpighi*. The character of the superficial cells is altogether different; they are compressed, flattened, dry, and horny, and constitute the *stratum corneum*. In some situations better than in others, we can see between these two layers an intermediate zone, consisting of a layer of cells of highly granular appearance —the *stratum granulosum*. Overlying this we find a thin, clear, glassy-looking layer, the *stratum lucidum*. Be it noted that the blood vessels do not penetrate into any of the above epidermic layers. If, now, the skin of a negro be examined, the pigment will be found in granular form within the deeper cells of the *stratum mucosum*, more abundant in quantity in those cells which rest on the surface of the *cutis vera*, and gradually diminishing in amount as we pass from the deeper cells to the surface, until at length it disappears altogether, and the superficial layers of the epidermis are left clear and transparent.

This pigment, of which melanin is an important constituent, is a highly complex body, possessing remarkably stable qualities. What we know of its chemical constitution we owe largely to the researches of Sorby, whose monographs on the subject still remain the standard authority. That observer conducted his investigations on the pigment of hair, which for all practical purposes may probably be considered as identical with that of skin. He was able to isolate three pigments, a brown-red, a yellow, and a black constituent. In the lighter tints of hair the two former colours or admixtures of them are alone met with. When the shade grows deeper, it is due to the addition of the black constituent in variable quantity. In absolutely black hair, however, after the black pigment has been separated out, a

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large proportion of the red and yellow pigments may still remain; thus Sorby found that some very black negro-hair contained as much of the red constituent as an equal weight of very red European hair. It would be interesting to pursue this subject further, but the space at our disposal debars us from being led into diverting speculations. It may, however, be noted that "blackness," as indicated either in hair or skin, is a very unsatisfactory term. Sufficient pigment may be present in a given weight of hair to impart to it a

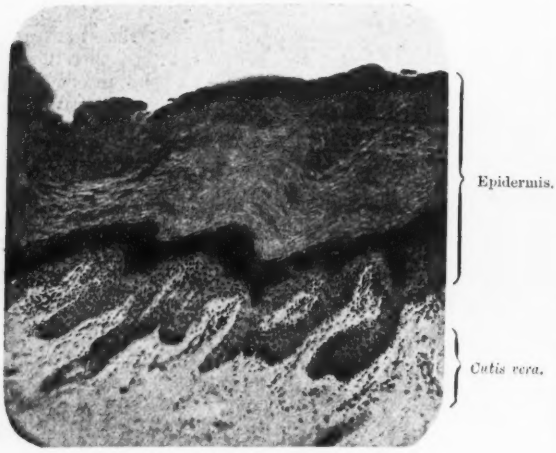


Fig. 1.—Photomicrograph of Section through Human Skin.

colour which to us appears black, whilst another sample of the same weight may yield three times the amount of pigment and yet present no difference to the naked eye from the first sample examined. It will thus be apparent that by our ordinary methods of classification blackness in the hair and skin may include a far greater range in the amount of pigment present than at first appears probable.

Without entering into a discussion of the probable sources from which this pigment is derived, it may be profitable to state that two opinions are held with regard to its production. Some maintain that it is elaborated by the cells of the deeper layer of the *stratum mucosum*, whilst others hold that the pigment is brought to the cells from other sources and is absorbed by them. The latter is more probably the correct view, and is supported by evidence of much weight. Thus, in the cells at the base of a hair follicle, the pigment may often be seen blocking and filling up the various inter-cellular channels; it finally appears within the cell and thus becomes intra-cellular.

In recent times, since surgeons have adopted the process of skin grafting to the healing of wounds and ulcers where the skin has been extensively destroyed, some interesting observations have been made. Thus, it has been noted that when the skin of a white man is grafted on to a negro the grafted patch assumes the normal tint of the individual, and, *vice versa*, when black skin is grafted on to white the pigment disappears. Such evidence seems to support very strongly the absorption as opposed to the elaboration theory. One more point with regard to the growth and structure of the skin may with advantage be referred to. The generally accepted view with regard to the regeneration of the superficial layers of the epidermis is, that the deepest cells of the *mucosum* gradually advancing to the surface undergo a horny change and are finally shed on the surface of the cuticle. So far such a view would meet all the requirements of the case in the white races, but, unfortunately, when we apply the same to the coloured varieties we are met with a difficulty at once. As we have seen, in the skin of the negro the deeper cells of the *mucosum* are the cells which contain the most pigment, whilst the superficial layers of the epidermis are free from colour. Now, if, as has been suggested, the deeper cells advance to the surface, it is only reasonable to suppose that they would carry their pigment with them, and hence the superficial layers would be as strongly coloured, if not more so, than the deeper strata. We have already seen that the pigment contained within these deeper cells is of a very stable character, resisting the action of the strongest acids and alkalies, and yet, if we adopt the accepted view with regard to the regeneration of the superficial layers, we must explain this disappearance of the pigment, which has not yet been satisfactorily accounted for. But may it not be that the accepted view with regard to the regeneration of the superficial layers is at fault? This is not the place to enter into a discussion of the matter, but possibly the growth of the epidermis is analogous to the growth of the cork cambium layer of plants. The *mucosum* corresponding to the green cells, the *stratum corneum* to the corky layer of the cambium, and, if such be the case—and there is much evidence in support of it—the deeper cells would advance towards the surface of the *cutis vera*, that is, they would grow inwards, whilst the horny cells would grow towards the surface.

Under these circumstances the active layers would be those to which attention has been already directed, viz., the *stratum granulosum* and the *stratum lucidum*. Such a view with regard to the regeneration of the epidermic layers would explain many of the difficulties which we encounter if we accept the current opinion. It would, as will be evident, do away with the necessity for explaining the mysterious disappearance of the pigment in the superficial layers, and would afford a reasonable explanation of

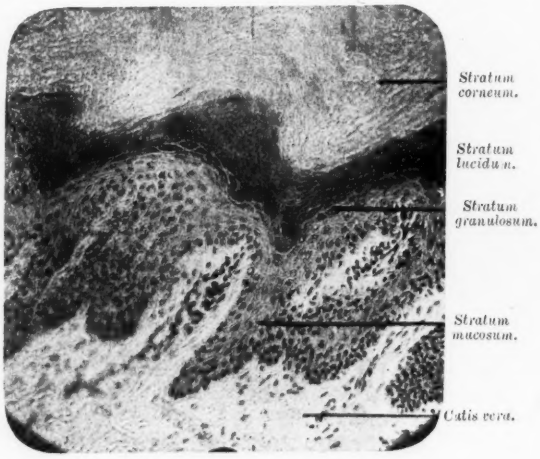


Fig. 2.—Photomicrograph of Section through Human Skin more highly magnified.

how it happens that in old age a negro's hair becomes white whilst his skin still retains its blackness, a detail to which we may subsequently refer.

Colour in man, then, may be said to depend on the presence or absence of these pigments. In the fair races there is probably a certain amount of the brown-red and yellow pigment present, but in so small a quantity as not to interfere with the translucency of the layers; in consequence of this the reddish tint of the highly vascular *cutis*

vera shines through the semi-transparent layers, and any change in the vascularity of the cutaneous surface of the body is at once apparent, whether it be brought about by external or internal stimuli. The bronzing of parts of the body, due to exposure or to the influence of sunlight, is probably the consequence of the increased cutaneous blood supply bringing more of the red, brown, and yellow pigments to the deeper cells of the *rete mucosum*. Freckles, which, curiously enough, occur most frequently on those with hair of a pronounced red colour, do not differ in any respect from the pigmented skins of the darker races, except in regard to their colour and their circumscribed appearance. In persons of dark complexion there is, in addition to the red, brown, and yellow pigments, probably a very slight admixture of the black pigment. This may be present in sufficient quantity to impart a blackness to the hair, but not abundant enough to destroy the fairness of the skin, though in exceptional situations its presence may be very evident.

By gradual transitions we may pass to those races in which the cutaneous pigment is present in sufficient quantity to mask the colour of the underlying tissue and impart thereby a sallowness to the complexion. These are the yellow races, and if sections of their skin be studied they will be found to differ from the highly pigmented cuticle of the negro only in the depth of the tint of the pigment contained in their deeper cells. By further steps we can pass

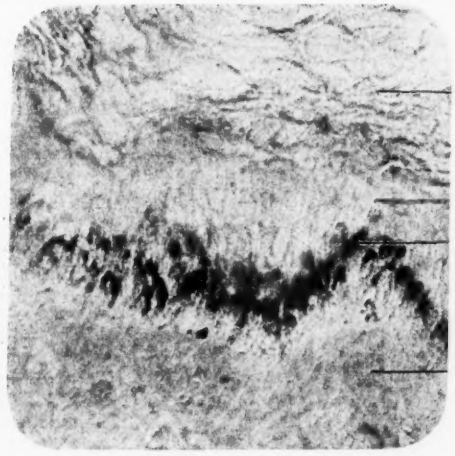


FIG. 3.—Photomicrograph of Section through Negro's Skin, showing distribution of Pigment.

easily from the yellow through browns of various sorts to the absolutely black races. Here the pigment is present in varying quantity, in some skins only the deepest row of the cells of the *mucosum* is loaded with the granules, in others the *mucosum* for several cells deep may contain the pigment, but it ceases to colour the cells before the *stratum granulosum* is reached. Thus, one skin, to all intents and purposes as black as another, may contain a much less amount of pigment, just as we have seen in the case of hair.

At present our method of classifying the colours met with in man is crude and not very trustworthy. The best means at our disposal is to employ the colour tables published either by the Anthropological Society of Paris or the Anthropological Institute of London. But even this is admitted to be far from satisfactory. The difference in the texture of the things compared causes a difficulty in the matching of the tints. For our part we think a much better plan would be the employment of carefully dyed pieces of kid, such as are used in the manufacture of gloves; these could be laid over the skin to be matched, and a much more reliable result obtained. Unfortunately, there would be some difficulty in standardizing the colours, but with some trouble this might be effected. Further, care must be taken to sample the colour of the skin on different parts of the body, for the more exposed parts are naturally those which display the darkest tint. In using either the English or French standard colour sheets, observers have found, as a matter of experience, that it is better to cut a hole in a piece of paper corresponding in colour with that on which the standard tints are printed, and then placing this on the skin to be examined, compare the patch exposed through the hole in the paper with the standard tints held side by side.

But a mere enumeration of standard tints does not assist us very much. In all cases it seems to us advisable that a lock of hair should, if possible, be obtained from the individual examined. As we have already hinted, we consider the hair a more important index of colour than the skin itself, because by taking given weights of hair, and extracting the pigments from it, we would be in a far better position to determine with accuracy the relative proportions of pigment present. It is assumed, of course, that the hair taken had not been subjected to the influence of lime or other "dressings," and that there was no evidence of senile change in the hair. No doubt the research would be arduous, but the results would amply repay the expenditure of time and trouble.

But, in addition, there are many other details which seem to have a more or less direct influence on colour production. Of these, temperature may be mentioned, diurnal as well as nocturnal. The moisture of the atmosphere. The nature of the soil. The diet. The manner of life, whether dwellers in dense forest or jungle—where, for example, the natives are screened from the sun's rays—or dwellers on the hills and plains, where they are most exposed to light and alternations of temperature. On the other hand, much information is wanted with regard to their susceptibility and immunity to disease of certain kinds. Apart from the anæmia consequent on the disease, whites, who suffer from malaria, appear to acquire a darker complexion. As has been hinted by Darwin, it is just possible that darkness of the skin may have been evolved, and is in some way connected with the immunity which coloured races possess from such diseases. There seems to be evidence, too, that in the dark races the size and consequently the weight of the liver is proportionately greater than in the white races. Unfortunately such data are not easy to obtain, but they would be of much service in enabling us to criticise certain theories that have been propounded. Certain it is that whites in tropical climates are much more liable to derangements of that organ than is the case with natives. Another line of enquiry which might much help us to solve the problems of the mode of production of this pigment, and the regeneration of the epidermic layers, would be a careful study of skin diseases in the dark races. We are not aware that it has been approached from this standpoint, but we are confident that it would prove a highly interesting field for research.

The above are a few of the facts which, it seems to us, would help in the elucidation of a problem about which in reality we know very little.

THE BAD LANGUAGE OF WILD BIRDS.

By Charles A. Witchell.

JUDGING by what one hears of the utterances of animals generally, it would seem that many of the notes of birds are interpreted too poetically by observers. In the case of many animals, the facial expression is capable of sufficient variation to clearly prove the character of the sounds by which it is accompanied. When a dog or a cat snarls, for instance, we know that the sound is intended to express hatred and a threat of attack. The lowing of a cow or of a calf, the bleating of a kid, the snorting of a horse, and its whinneying, can hardly be misunderstood.

But the meanings of the cries of birds are less obvious. The cooing of a dove, or the warbling of a fluent singer, may seem to be as expressive as any note of the quadrupeds just mentioned; but when attention is given to the actions which accompany the cries of birds, an observer finds that some very pleasant sounds are incidental to very unkind behaviour. In a few cases the combativeness of a bird is fairly well suggested by its cry—as occurs in the common fowl, whose "crow" is as defiant as a bugle blast. The shriek of the woodland jay, also, is very expressive. These sounds, however, do not represent the greatest passion. We must listen to birds actually engaged in combat in order to hear the expression of their utmost hate—their worst language; and, listening thus, we often make the discovery that the sound accompanying an attempt at murder is closely like (sometimes apparently identical with) sounds which seem to be joyous song.

The little brown wren mounts the top of the hedge and sings a sprightly song. The notes seem to be the spontaneous outpouring of joy. Twenty yards farther along the hedge another wren mounts to the topmost twig, perks his tail, and utters a similar lively tune. Number one flies a little way towards number two, and sings again. Here, then, is a pleasing sylvan duetto! But soon the wrens are fighting furiously, tumbling over and over each other at the bottom of the hedge, while at intervals snatches of the same little ditty are heard. They sing, in the intervals of fighting, what seemed a song of peace and love. In view of what the birds are doing, it may be surmised that their language at this moment is very bad indeed.

But instead of the sprightly wren, the sedate robin may be under observation. If a singing robin be watched, and especially in autumn, he will be seen to attack any other singing robin which may be near; yet the birds will be singing all the while, and their songs will be like the ordinary songs of the species, though a trifle sharper in tone. The music is evidently intended to convey the animosity of the birds. The hedge-sparrow twitters in quite a subdued tone when fighting; yet it nevertheless seems to be singing. The willow wren sings its ordinary song when about to attack a rival. The chiffchaff, however, does not employ his cheerful strain on the like occasion. The nightingale is somewhat pugnacious, and I have several times seen two fighting (I once saw three), but no song notes were then given.

Among the finches and buntings, a combat is often accompanied by a slight twittering, somewhat similar to rapid repetitions of the call note, malice and love having thus the same tone; but some species employ a particular note. The chaffinch has only one cry when fighting, be his enemy bird or beast. That cry is the common note "tink," or "fink." The greenfinch then utters a low rough cry, something like "gupgupgup," repeated very rapidly. The male house-sparrow is one of the most silent of fighters. (The casual observer will say that this is one of the most untrue of allegations.) When male sparrows intend to fight, they hop about restlessly near each other, their feathers held very close, and their tails flirting up and down almost continuously. Presently one of the birds darts at the other and tries to give him a lance-thrust with the bill, the other springs aside, and the aggressor alights near, and the flirting of the tails continues. But all this time the birds utter no cry, When the contest has reached the stage of a struggle in the nest-place, however, there is some noise, scuffling and screaming. The cries are not the tones of love; they are expressions of fury. When male sparrows are noisily clustering around a female bird, their cries may be those both of love and fear; but these assemblies require close attention before the nature of the cries employed can be ascertained.

There are many species which give the full song during combat. I have heard the full song of the tree pipit sung by a bird fighting furiously. When first seen the birds were fighting in flight; they fell to the ground together, and in this position, and when I was not more than three yards distant, one of them uttered the full song, including even the final "whee whee whee," which is usually uttered while the bird is descending on outstretched motionless wings.

The common pied wagtail, when attacking another, utters cries which seem to be his ordinary call-notes; and the same incident may be observed in the skylark. Last summer a lark was singing as usual above his meadow, and another singing lark approached and swooped at him. The new-comer was vigorously repulsed, though not until some pretty flying and stooping had been performed; and the birds were singing all the while. They were evidently rival neighbours, but in this instance, as in those above mentioned, mere rivalry and emulation would not account for the behaviour of the birds. This must be credited to hatred and ill-will.

In many species, therefore, we cannot easily distinguish the tone of love from that of hate, unless we also consider the contemporaneous behaviour of the birds. And even then we may easily err; for when a melodious singer is perched in a tree, or poised on the wing, we cannot tell whether his notes are addressed to his mate, or to his enemy. Unfortunately, it is not only among birds that the same tone is employed towards both of these objects!

So far, I have not met with anyone who is paying attention to this branch of bird-song; yet it is a really important one, with a basis of fact to indicate the lines of investigation to be followed. The sparrow and several other finches have cries which are preferably employed during combat. Some singers, as the robin and thrush, sing when fighting with others of their own species, but not when fighting birds of alien species, and there are many which do not sing at all when fighting. The starling is one of the last. When threatened by another, or meditating an attack, it is silent, and at the moment of the encounter only a slight cackling is heard. This sound may most often be heard in September and October, when the birds are striving for the possession of nesting sites in which to roost during the winter.

But though the starling never expresses malice in song, he undoubtedly often sings a love-song, for he will fan his mate with his wings while singing; and she, with head raised and tail drooping, adds a softer strain to his music.

The blackbird is another singer which never employs song as a threat. His combats are accompanied by a metallic clicking sound, with which most of us are familiar. The song thrush, however, never has a contest with another of his kind without twittering an accompaniment.

It cannot be said that any of these birds is restricted to one set of tones both for anger and for song (as occurs to some extent in the common duck), for all of them have special cries of alarm and anger, which they utter when frightened by a predaceous beast. The robin employs his rattling note of alarm; the thrush, when its nest is threatened by the jackdaw, makes a great outcry like that of the mistle thrush; the tree pipit has an alarm which is given when the nest is threatened; the brown wren repeats a common note when frightened; and the others have a similar variety of cries.

These remarks are intended to prove the importance of carefully analysing a bird's notes before attempting to define their meaning. The subject is so new that anyone who will carefully notice may do good work, and at no cost of bird-life. Nor can it reasonably be urged that this analysis would rob the poet of some common symbols. No one would unnecessarily deprive him of any, but he should know that while the blackbird, starling, chaffinch, and others may be pouring out the truest love-notes, the robin, thrush, hedge-sparrow, and others, though also singing, may be using the very "Billingsgate" of birds.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—VII.

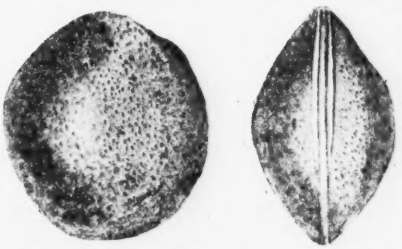
By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

THE BOX CRUSTACEA.

IN an essay on Boxes, a writer might find a cue for discussing the merits of thrift and the weakness of the miser, the proper and the improper discipline of children, the implements of a laundry, the arrangement of a theatre, the situation of a country seat, the structure of a cart-wheel, a pump, or a drain. He might speak of trees and their uses, of coaches, of coats, and of Christmas presents. He would, naturally, consider the receptacles which have been contrived for keeping the garments of the living and the remains of the departed. To add to this miscellaneous assortment a mention of the Box-crabs would be an unfruitful eccentricity, because the species of *Calappa* which have been so designated, though highly curious in themselves, are no more boxes than crabs in general. But, for all that, there is a veritable group of Box Crustacea. Here the boxes are alive, and, besides being just large enough for what the owner wants to keep in them, they have the magic faculty of increasing in size exactly to match the increase of the contents. The animals of this group are known to science as the Ostracóda, the shelly group, so-called because they bear an external resemblance to "shell-fish," to bivalved mollusca, such as mussels and cockles. They have, therefore, no sort of likeness, outwardly, to that popular ideal of a crustacean, which hovers between a crab and a shrimp, but must be compared with other entomostracans, such as the *Estheria* figured in our first chapter, or the *Daphnia* in our fourth.

The collector of crabs and lobsters is apt to scare the members of his household by the odour of the specimens, if he keeps them dry, or by the continued demand for bottles and corks of all sorts of unprocurable sizes, if the specimens are to be preserved in spirits or formalin. House-room also soon becomes a consideration. But with the Ostracóda it is different. Many of them are less than one millimetre in length, and they are seldom broader than long. Now, a millimetre is just a twenty-fifth part of an inch; see, then, how convenient it is for a naturalist, whose space accommodation is limited, to be able to place six hundred and twenty-five specimens on a plot of ground, or a piece of black card, an inch square.

To the unscientific Briton it may appear pedantic, unpatriotic, and needlessly obscure to give scientific measurements in French millimetres. But there is this important convenience in it, that a millimetre means the same measurement all the world over, whereas the English word "inch" translated into the French "pouce," or the German "Zoll," changes its meaning at each step, the German inch being equivalent to twenty-six millimetres, while ours answers to twenty-five and the French to twenty-seven. Now that science has become more than ever cosmopolitan, it is a serious evil to use words such as inch and foot and fathom, which are untranslatable, except by the help of a sum in fractions.

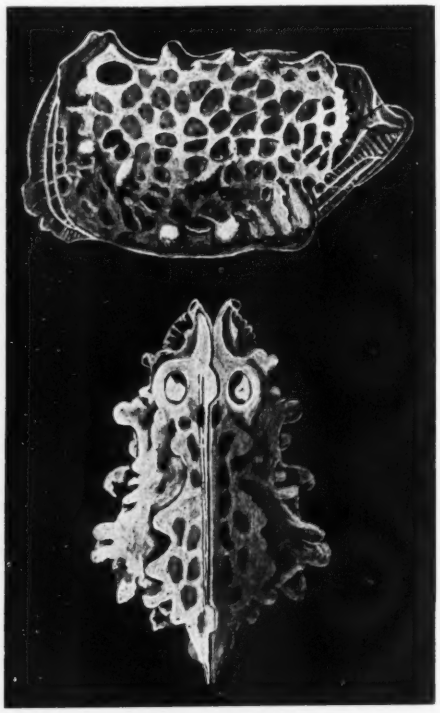


Polycope orbicularis Sars, lateral and dorsal views. From G. S. Brady.

With the Ostracóda, at all events, the millimetre will be found to be a specially suitable unit of measurement. Their personal proportions never require to be reckoned in feet or in inches. Nevertheless, as in all other groups of animals, there are among them disparities of size, from the dwarfish to the elephantine, but still all within a modest, unalarming compass. Their delicate little corpses dry up within their own organic sarcophagus, and need no embalming to make them inoffensive. They remind one of that romantic country in which the old men never died but only shrivelled, and could, by process of steeping in hot water, be occasionally revivified to answer the enquiries of a younger generation. In regard to some of the specimens described in the "Monograph of the Marine and Fresh-water Ostracóda of the North Atlantic and of North-Western Europe" (1896), the authors, Dr. G. S. Brady and Canon Norman, say, "it struck us that, notwithstanding their dried condition, it might yet be possible by maceration to get some idea of the withered inmates of the shells. We therefore made experiments, and succeeded in restoring the animals beyond our most ardent expectations." The authors are evidently innocent of any suspicion that the process had ever been applied with equal success to human beings.

Besides being easy to keep and hard to decay, the Ostracóda have another advantage in the universality of their aquatic distribution, so that some of the species are extremely easy to obtain. Not only are these organisms distributed over all the water-covered floor of the existing world, but their range extends through the fossiliferous strata from the Cambrian to those which are now being formed. It must, however, be admitted, and should be borne in mind that we cannot macerate carboniferous or cretaceous forefathers of the Ostracóda. They no longer yield to any witchery of rejuvenescence to answer our questionings. Only the boxes, the external valves, remain, preciously imperishable, saved, as the moralist may be pleased to observe, not by any heroic grandeur but by their insignificant smallness, and a mean dwelling in the slumberous ooze. The strong likeness between the valves of some species still living and the fossil valves belonging to various geological periods makes it probable that in the

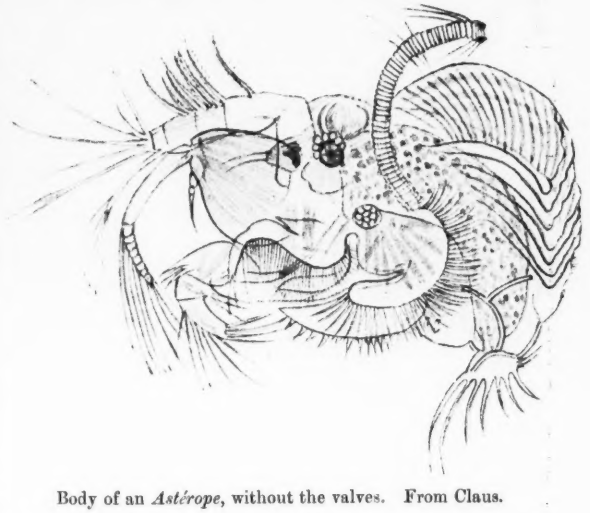
inward parts also the ancient forms bore a near resemblance to the modern. The student of the fossils will find a voluminous literature at his disposal, foremost among the authorities being our own countryman, Prof. Rupert Jones, whose researches upon these organic remains have been continued during the last fifty years, and still continue. Half a century of work upon the same kind of material is some testimony to the fascination of a subject which can bring little in the way of fee or fame, but rather, like virtue, is its own reward. Another devoted student of the Ostracóda, both recent and fossil, was the late Dr. David Robertson, who, by living to be almost ninety years of age, showed that the pursuit was at least not inconsistent with longevity. How and when and where to obtain the fresh-water forms will be found concisely explained in Robertson's own words in Appendix B to "The Naturalist of Cumbrae."



Eucytherura gibbera, lateral and dorsal views. From G. W. Müller.*

Here it may suffice to say that Ostracóda are to be found in the depths of the ocean and on its shores, in slow-running streams, in marshes, ditches, and ponds. The streams and the pools need not be very extensive, for Brady and Norman explain that *Scottia Browniana*, originally described as a fossil, was found on the shores of Loch Fadd, in the Isle of Bute, under the following circumstances: "A spring rises on a bank close to the loch, into which the water finds its way among the grass; the water is nowhere trickling more than two or three inches deep among the herbage. Here, amidst multitudes of *Difflugiæ*, *Scottia Browniana* lives, with *Ilyodromus Robertsoni*, *Herpetocypris reptans* and *tumefacta*, *Cypridopsis Newtoni*, *Candona candida* and *Candonopsis Kingsleii* as its companions." This is but a small rivulet to furnish seven species and almost as many genera of the group. Still more singular is the habitat of Fritz Müller's *Elpidium bromeliarum*. This species, which is now referred to the genus *Xestolebéris*, lives in fresh water, though belonging to the Cytheridæ, a family almost exclusively marine. It is nearly as broad as long, and much broader than high. In shape it is compared to a coffee berry, and, if reliance can be placed upon form, it appears to have no nearer relative than the *Elpe pinguis*, a Silurian fossil, five times as large as itself. In its ancestry, in its outline, in its absence from the sea, this little species is remarkable, but, above all, in the reservoirs that furnish its dwelling place. These are aerial though not in the clouds. They are the miniature cisterns formed by rain water in the leaves of parasitic plants, the Bromelias of Brazil. Those pools are visited by innumerable insects, by worms, isopods, arachnids, myriapods, batrachians, and even cobras, but, in the opinion of Fritz Müller, the little *Elpidium* is almost the only animal that lives in them from its birth to its death. As it has no means of migrating of its own accord from one Bromelia to another, whether on the same or different trees, and as almost every Bromelia has the Ostracóda, the inference is that, like the pollen of flowers, they are carried from plant to plant by some of the more freely locomotive visitors.

Without visiting the forests of Brazil, many species of Ostracóda can be procured from various waters by the use of a fine net at the end of a stick, by the washing of water-weeds, and the sifting of dredged-up mud. So far as the "boxes," or closed valves are concerned, there is not much to choose between fossil and recent specimens. A new interest begins with the study of the internal machinery and observance of the habits of the living animal. The resemblance to a mollusc is at once seen to be purely superficial. There are here the eyes and the jointed appendages



Body of an *Astérope*, without the valves. From Claus.

of an arthropod. There are also the two pairs of antennæ in which crustaceans rejoice, while the poor insect has to be content with a single pair. There are the mandibles or jaws, without which no lofty destiny is complete, and after these come four or five other pairs of appendages, beginning with the first and second maxillæ, and ending with pairs to which in some instances the name of legs can only be applied by courtesy.

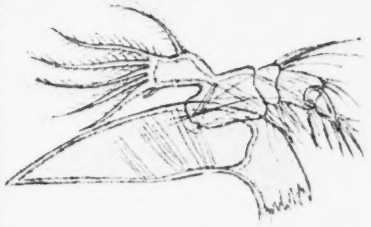
It is not to be denied that beginners may find themselves, at first, bewildered as to the sorting of all these organs or limbs. That they are where they are without the least undue crowding and crumpling is a miracle of natural

* Fauna und Flora des Golfes von Neapel. Ostracoden. von G. W. Müller, 1894.

packing. One can only feel that this is not an original design, but an adaptation gradually brought about. So anxious have the creatures been to have all the precious items of their apparatus shielded within the valves of their shelly portmanteau that they have wedged them together, without much minding the natural order so long as their efficient working was not interfered with. Even that point has perhaps been a little sacrificed, seeing that some of these essentially aquatic animals are without the essentially aquatic accomplishment of swimming. This is ignominious, but it is safe. They can walk, they can burrow, or they can cling. Thus they can secure food and a contemplative life without natatory gadding among the ferocious occupants of the watery empyrean.

There are four sections of the Ostracóda, one of which, under the name of Podocópa, comprises fresh-water species as well as marine, while only marine species are known in the other three. In all of them the appendages, though they can in general be identified in their serial order, differ often very strikingly in their forms. This is scarcely to be wondered at, since some of the species come from depths of the tropical ocean, others from little grimy puddles on land; some have shells of polished smoothness, while others show the most ornate rugosities; some are less than a millimetre long, others stretch their vast length to seven or eight millimetres; and one almost incredible monster from the Pacific is said to measure more than an inch.

The differences in the organs are not without a philosophic as well as, doubtless, a functional value. Observe, for example, the mandible of *Megalocypris princeps* Sars, a princely fresh-water ostracode from South Africa. Its basal joint forms a strong transverse trunk with a dentate biting edge, such as is so commonly seen throughout the Malacostraca, and from this trunk rises a jointed palp. It has been already explained that the joints of a mandibular palp must really correspond to the joints of a leg, in spite of the utterly unleglike appearance of the ordinary mandible. Turn now to the mandible of an *Astérope*. It will be seen to be completely leg-like. Its basal joint is not transverse but longitudinal, end to end with the joints which follow it, while the biting process, though present, is quite unobtrusive. This comparison is like the writing on a sign-post, only, instead of directing us how to reach a town or a village, it directs us how to reach a conclusion. It points towards this deduction—that the strangely diversified forms of mandible throughout the crustacea may have originated from a simple string of similar joints. The form of the mandible in *Megalocypris* forcibly intimates that the Ostracóda are not only connected with other groups of Entomostraca but with the Malacostraca as well. A genealogical unity of all the crustacea thus springs into view, and this can only be grounded on the theory of evolution. Fifty years ago, in public estimation, that theory was nowhere, and now it is everywhere. When it first came into the open sunlight it greatly affected not only the thoughts but the lives of men. It made some become naturalists who would otherwise never have given more than a passing glance to natural history. Now, indeed, it is so much taken for granted that men can hold it, as they hold other great doctrines, with no grounds for conviction and in placid companionship with a thousand inconsistent views. But that is not the fault of the Ostracóda.



Mandible of *Megalocypris princeps*. From Sars.

Mandible of *Astérope*, sp.

To return to the genus *Astérope*, in which the mandible is like a leg, we find that here the penultimate pair of appendages, which according to custom ought to be a pair of legs, or at least leg-like, is more like a pair of flattened out dust-pans. Its principal or its most obvious use is not wholly out of harmony with the appearance. The strongly spined terminal part of the animal, known as the caudal fork, in repose is folded within the valves. In the alternate unbending and rebending of this spring tail the animal finds its most powerful source of locomotion. But every alternate stroke protrudes the finely serrate spines into the muddy or gritty surroundings of the outside world, and some of the particles are carried back into the scrupulously neat but limited accommodation within the valves. There the legs, which have been modified into a sort of combination of dust-pan and brush, receive between their plates and hairs the bespattered spines of the tail, and cleanse them. But here the old difficulty arises. *Quis custodiet ipsos custodes?* Who is to brush the brushes? This question is answered by nature in a manner truly remarkable. The next pair of limbs are converted into what servants call "a general" and what their employers call "a maid of all work." In the family Cypridinidæ, to which the genus *Astérope* belongs, this leg "represents a long, vermiform, annulate, extremely movable appendage." It is employed to sweep the outside of the valves, thus passing into the water for its own purification, and within them it brushes the brushes, it plies between the laminar branchiæ or breathing organs, and above all it attends to the nursery, by working about among the eggs in the brood-pouch, making things wholesome for the hopes of the race, the coming generation of the Ostracóda. On these and a hundred other matters of interest concerning this group the student will find copious instruction in the works of Sars, and Claus, and Brady, and Norman, and Robertson, and many others, to whom their writings will introduce him, nor will he go far in his researches without discovering that the fine monograph by G. W. Müller is indispensable to satisfactory progress.

Brushing feet of *Astérope*, sp., slightly separated.

Annular cleansing foot of *Astérope*, sp.

SECRETS OF THE EARTH'S CRUST.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

INTRODUCTION.

IN this series of papers the writer proposes to touch on some of the questions that are prominent in the minds of geologists at the present day. In so doing, it must become clear in each case that the position now reached is the result of a long series of observations, extending back throughout the century. There is

no "new geology," any more than there is a new heaven or a new earth. In this, as in other sciences, the great discoverer is preceded in his triumph by the veteran legions who have seen more service than himself. The records of patient labour, sometimes laid aside owing to their obvious incompleteness, the work of men in candle-lit laboratories, or in mining camps among the mountains, may at length receive their interpretation, and fall into their place in the great argument of reason. Everywhere these friendly linkings with the past provide new stimulus for research; and it is not always the young and undefeated who sound the *réveil* upon the field.

I.—THE UNSEEN CORE.

The public mind has always been impressed by the fall of strange bodies upon the earth, sometimes from our own atmosphere, sometimes from outer space. "Red rains," regarded as showers of blood, have been held to presage deadly evils; and the descent of small frogs, or even fresh-water fishes, has been looked on as a dubious blessing. The explanation that red mud, and the accessory frogs, may be carried up from drying pools by whirlwinds, and that the contents of crater-lakes may be flung broadcast by volcanoes, has hardly allayed popular suspicion. Still more impressive have been the records of the fall of meteoric stones, at times accompanied by the flash of a visible meteor. The tradition of such occurrences was, in old time, passed from one hearer to another, and even ordinary lightning became credited with an accompanying "thunderbolt." Concretions of metallic ores, such as the marcasite nodules of the chalk, are even now pointed to as "thunderbolts"; and this fact, based on their superficial resemblance to true meteorites, shows that the latter must have been observed with tolerable frequency. Meteorites that had actually been seen to fall were, naturally enough, accounted precious and miraculous, and were occasionally preserved in churches. In still more ancient days they were objects of worship, and were associated with recognised divinities, such as Diana of the Ephesians. The philosophers of the Renaissance, however, swept aside a number of valuable traditions, in their very pardonable zeal, and they refused to believe that meteoric masses could reach our planet from without. Gassendi, who saw a meteorite fall in Provence in 1627, thus attributed it to some unknown terrestrial eruption; though a mass of fifty-nine pounds, descending in proud isolation on the soil of France, surely deserved further consideration.

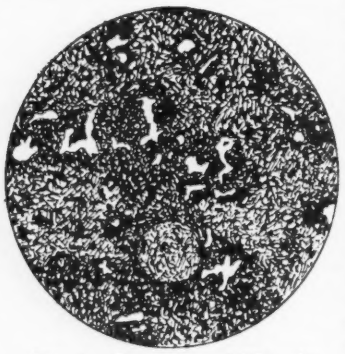


Fig. 1.—Cut surface of Meteorite (Sporadosiderite) which fell at Mócs, Koloza, Transylvania, 3rd Feb., 1882. ×12. Bright irregular specks of nickel-iron lie scattered in a ground consisting mostly of basic silicates. One of the globular "chondroi" shows as a light-coloured circular area in the section. (From a specimen in the Royal College of Science for Ireland.)

It was left for Chladni, in 1794, to revive, on scientific grounds, the well-founded belief of older days. He particularly commented on the mineralogical peculiarity of the "Pallas Iron," a huge block of nickel-iron and included olivine, found in Siberia in 1749. This appeared to him not to resemble any known terrestrial material. In the same belief, Sir Joseph Banks collected specimens from Siena (1794), Yorkshire (1795), and Benares (1798), and submitted them to Mr. Edward Howard. Aided by the Comte de Bournon, Howard published the first truly scientific report on "certain stony and metallic Substances which at different Times are said to have fallen on the Earth; also on various Kinds of native Iron."* Nickel was here recognised as a constituent of the iron masses; and Howard, while offering no conclusion, clearly inclined towards the meteoric view. When an idea has been denounced as superstition, it is slow to come again into favour; but the fortunate fall of stones at l'Aigle, in Normandy, in 1803, gave the French Academy an opportunity of forming an independent opinion. Biot's report converted those who sent him into the field; and the genuineness of the fall of stones "from heaven" has not been questioned subsequently.†

Among the meteoric stones investigated from time to time, a number were found to consist of metallic iron, with some five or ten per cent. of nickel. Only a dozen or so of these iron meteorites have actually been seen to fall, including one near the Wrekin in 1876; but many other conspicuous masses, found lying on the surface of the earth, have been assigned a meteoric origin, on account of their resemblance to specimens about which there is no manner of doubt. One of the striking features of many such irons is the development of characteristic figures when a polished surface is etched with nitric acid. Von Widmanstetter (also known as von Widmanstätten) observed these as early as 1808; and it has since been shown that the systems of crossing bands and lines are due to the varying degree of resistance of different alloys of nickel and iron. In the most easily attacked layers, there may be fourteen parts of iron by weight to one of nickel; in the most resisting parts, which remain as thin bright streaks above the dull etched areas, the proportion of iron to nickel may be only six to one. The bands thus developed on a polished surface are usually the edges of four sets of layers grouped parallel to the faces of an octahedron, and represent successive zones or stages in the growth of the crystalline mass. The iron particles contained in some stony meteorites are much richer in nickel than are the ordinary iron meteorites; which proves that highly nickeliferous ores may yet some day descend in mass from space. Indeed, the material from the province of Santa Catharina, in Brazil, with 63·69 per cent. of iron, and 33·97 per cent. of nickel, and that from Octibbeha, Mississippi, with 37·69 per cent. of iron, and as much as 59·69 per cent. of nickel, are commonly regarded as truly meteoric.

All these iron masses, ranging from mere pebbly particles up to blocks measuring several feet across, present striking differences from the ordinary materials of the earth's crust. Metallic iron is one of the least important constituents of the rocks to which we readily have access. Even now, it has not been recognised as a common mineral, though it may occur in the form of minute grains in a number of basic igneous rocks. The iron familiar to us in analysis, which forms, according to Mr. F. W. Clarke, some five per cent. by weight of the earth's crust, occurs as the oxides (magnetite, hæmatite, or limonite), as the sulphides (pyrite, marcasite, and pyrrhotine), as the carbonate (siderite), or shut up in combination in a variety of common silicates.

Terrestrial native iron, however, has long been reported from the platiniferous sands of Brazil, not to men-

* *Phil. Trans. Roy. Soc.*, 1802, pt. i., p. 168.

† *See* L. Fletcher, "Introduction to the Study of Meteorites," issued as a guide-book at the British Museum.

tion other more or less authenticated instances. In 1852, Prof. Andrews,* of Belfast, powdered up certain Irish dolerites and basalts in a porcelain mortar, extracted all magnetic particles by means of a magnet, and examined these particles under a microscope. When moistened with an acid solution of copper sulphate, the magnetic iron oxide (magnetite) undergoes no change; but metallic iron is attacked, and is replaced by a deposit of pure copper. Andrews found in this way a small number of particles of pure iron—three or four from one hundred grains of powdered rock—and the largest deposit of copper measured one-fiftieth of an inch in diameter. The dolerite of Slemish yielded the best results; but the basalt of the Giant's Causeway gave sufficient indications.

Other workers repeated these observations on Continental rocks, the result being that metallic iron seems regularly associated with the dark heavy "basic" rocks, basalts, and so forth, and to occur also, but more rarely in rocks rich in silica, such as granite.

But it is only in the last few years that geologists have been assured of the presence of considerable masses of native iron in the earth's crust. Nickel-iron has long been used by the Eskimo for knife-blades and hatchets; and it was suspected that some large meteorite was being worked as a convenient mine. Nordenskiöld, in 1870, observed a block of iron in some ballast taken on board near Godhavn, in Disko Island; and in time the true source was discovered by him at Uigfak, or Ovifak, a spot difficult of access, but now one of the best known mineral localities in the world. Here, on the shore, some magnificent blocks of nickel-iron were lying, exposed to the sea-waves. The largest, which is now in Stockholm, measures six feet long, and weighs about nineteen tons. On etching, the well-known "Widmannstätten figures" were revealed, and nickel, varying from 1 to 6·5 per cent. (usually about two per cent.) has been found on chemical analysis.

It is no wonder, then, that the Ovifak masses were at first believed to be meteoric. Even when nickel-iron was found in the adjacent basalt of the coast, it was thought that a meteoric shower might have occurred while the lava was still hot and viscid, and that the fragments had become consequently entombed. But other discoveries followed in the same neighbourhood, notably those of Steenstrup, in 1875, and it became admitted that the iron was a true constituent of the Miocene basaltic lavas. Several writers then saw in it the result of the reduction of iron oxides by the material of a coaly bed, which the lava was supposed to have absorbed; so reluctant were some geologists still to admit that native iron is, in any quantity, a true constituent of the earth's crust. The carbon present in the nickel-iron, amounting often to two per cent., might be attributed to the same source; but traces of carbon are well known to occur in most truly meteoric irons. Dr. Lawrence Smith showed that metallic iron was included in even the felspar of the Disko basalts, and the meteoric theory, at any rate, may be said to have been abandoned for fully twenty years.

Meanwhile, attention was called to other examples of terrestrial iron, commonly alloyed with nickel, and sometimes associated with magnetic pyrites (pyrrhotine). Let us note in passing that troilite, the iron sulphide frequently found in iron meteorites, is probably identical with the pyrrhotine of our own earth's crust. This later series of discoveries only confirms the belief that terrestrial iron is typically associated with the most basic masses of the crust. These basic masses have been, on many grounds, regarded as more deep-seated in their origin than the lighter granites and gneisses, which play so large a part in the constitution of the crust.

Near Biella, in Piedmont, grains of nickel-iron occur in a gold-bearing sand; here the nickel forms seventy-five, and the iron twenty-five per cent. In Oregon, pebbles have been found containing twenty-three per cent. of iron, with sixty per cent. of nickel, and twelve of silica. The most remarkable discovery of this nature, however, is probably the "Awaruite" of New Zealand. In 1885, Mr. W. Skey observed this substance as small grains in a sand from the Gorge River, near Awarua (Big Bay), on the west coast of the South Island of New Zealand. Its composition shows that it is a nickel-iron, in which there are two parts of nickel to every one of iron. Prof. Ulrich caused its true source to be traced in the wild country north-east of Awarua; and it is found to occur with pyrite and chrome iron ore, scattered through typical peridotites. The "peridotites" are rocks rich in magnesia and iron oxide, and containing only some forty-two per cent. of silica; they have been recognised, all the world over, as the natural matrix of ores of chromium and nickel. Metallic platinum is also traced to peridotites; and metallic iron is recorded, as we have seen already, from the platiniferous sands of Brazil.

Here we have a series of links, which make it now obvious that materials, once supposed to be entirely meteoric, may occur in mass in the lower regions of the crust. Mr. Skey compared his "awaruite" with the substance found at Octibbeha City, Mississippi, in 1857, which has been already referred to as containing some sixty per cent. of nickel. He was criticised for not observing that the "octibbehite" was of celestial origin; but the tables have now been turned by the suggestion that both this and the nickel-iron of Santa Catharina are not meteorites, but have been washed from some portion of our own crust. How many of the great iron masses found in spots difficult of access, and hitherto regarded as meteorites, may ultimately be traced to some igneous mass, intruded through the local strata?

FIG. 2.—Cut surface of Basalt from Ovifak, Disko Id, Greenland. × 12. Bright irregular specks, composed almost entirely of nickel-iron, lie scattered in a dark ground, which consists of the silicates of the basalt. Compare with Fig. 1. (From a specimen in the Museum of Science and Art, Dublin.)

Already the abundant specimens of "meteoric" iron from Cañon Diablo, Arizona, have come under suspicion. There is now, in fact, no certain character left to us by which we can decide whether a nickel-iron mass is of celestial or of terrestrial origin, except, perhaps, the nature of the surface. This presents remarkable pittings and depressions, in the case of iron that has been projected with great velocity through the air.*

* *Report Brit. Assoc.*, 1852, p. 34. See also "Scientific Papers of Thomas Andrews" (1889), pp. 231, 399, and 507.

* See on this matter, and for an examination of meteorites in general, the classic work of Daubrée, "Études synthétiques de géologie expérimentale" (1879), pp. 473-703.

XUM

By far the commonest meteorites, however, are those called "sporadosiderites," in which small specks of nickel-iron lie scattered through a ground composed of silicates. Ordinarily, certain structures are present, notably the globular crystalline aggregates called *chondroi*, which were produced in the mass by some special conditions of consolidation. The minerals present, however, are in general those of our own basic igneous rocks. A number of substances regarded as peculiar to meteorites may yet be found in the deeper parts of the earth's crust. Even the strange form of silica, asmanite, so carefully separated by Story-Maskelyne from the meteorite of Breitenbach in Bohemia, is now believed to be identical with the mineral tridymite, which occurs in the cavities of so many terrestrial lavas.

Whether the internal core of the earth is a liquid under great pressure, or whether it is a solid mass, it is certainly of much higher density than the ordinary rocks of the outer crust. Mr. J. H. Poynting* has recently reviewed the long series of researches by which the mean density of the earth has been determined. Among the results, none stand out more prominently than those achieved by Cavendish with the torsion-balance in 1798. We now know that, while the crust has a mean density of about 2·6, the earth as a whole has a density of 5·5; and the simplest explanation of this is that the denser materials are accumulated within, while the lighter ones float, as it were, on the outside. The crust, by which we mean that part accessible to ourselves, is of trifling thickness; already we seem to be within touch of the basic masses which underlie it, with their included blocks of metal. In Greenland and New Zealand, for instance, we find brought up to us the layer corresponding to the "sporadosiderites" of space; and at Ovifak we seem to have glimpses of an actual iron core, corresponding to the metallic meteorites.

Is such a core an improbability—a core in which iron predominates, but in which other native metals may lie abundantly dissolved? Astronomers agree that the meteorites, drawn from time to time to the surface of the earth, belong to swarms circling in the solar system. The remarkable uniformity in their characters points to one of two things; they either originated in the disruption of a single planetary body, or else the great mass of extra-terrestrial matter is far more basic, far more rich in native iron and nickel and cobalt than are the common rocks of the earth's crust. Both these suggestions may be true; they do not contradict each other. In the meteoric bodies that were, by some astronomical "accident," sent flying into space, we may find the best representatives of the inner layers of our earth. At present our attention becomes more and more directed to the olivine-rocks, the serpentines, the "picrites," and their allies, which here and there break through the crust, bringing up such a wealth of nickel-ores and iron-ores from below. The contents of such masses, particularly any nodular groupings that appear to differ from the ordinary rock, must be scrupulously examined. We are as yet only feeling our way on the outskirts of the unseen core.

Notices of Books.

The Play of Animals: a Study of Animal Life and Instinct. By Prof. Karl Groos. Translated by Elizabeth L. Baldwin, with a preface and an appendix by Prof. J. Mark Baldwin. (Chapman & Hall.) 10s. 6d. Observations of the various activities of animals are of deep interest, and their value in tracing the course of psychological development cannot be over-estimated. But the tendency to consider all exhibitions of animal intelligence from an anthropomorphic point of view—and it is difficult to do otherwise—makes it essential to exercise extreme care in such observations, so that the acts shall be described without consideration as to the possible why and wherefore of their performance. Popular volumes on natural history topics often contain instances of the more human, but less scientific style of recording observations. In the present work, however, a sound and thorough statement of the facts and observations referring to one of the phases of animal intelligence is presented, and we think that few outdoor naturalists would fail to derive benefit from an examination of them. More than this, we will say that before valuable observations of animal psychology can be made, the naturalist must be acquainted with the contents of a volume of this kind. Prof. Lloyd Morgan has done yeoman service in the same field in his various works on the habits and mental processes of animals; and the course of mental evolution is traced in Romanes's works. We have also Mr. Arthur Thomson's popular book on various aspects of animal life, and Houssay's work on the industries of animals. Prof. Groos's volume deals with quite a distinct aspect of animal activity, and supplements all that have preceded it. The anecdotes of intelligence in animals recorded in it have been selected with discrimination from a vast store, and their bearing upon biology and animal psychology is clearly pointed out. Play is regarded as a real instinct, and Mr. Herbert Spencer's theory that it represents "surplus energy" is discussed and abandoned. The observations described, the classification adopted, and the interpretations suggested command attention, and Prof. Mark Baldwin's notes give additional value to them all. As a contribution to the literature of animal life, in which the transition from animal to human intelligence is indicated, the volume should be cordially welcomed.

Creation Records. By George St. Clair. (David Nutt.) 10s. 6d. The theory which was put forward some time ago by Sir Norman Lockyer to explain the foundations of Egyptian mythology by astronomical considerations is brought into prominence again by Mr. George St. Clair. The idea of the book, briefly expressed, is that the myths of Egypt are all related to one another, and are neither separate fables nor idle fancies. That they reveal, moreover, a religion intimately dependent upon the stars, and tell a true story of astronomical progress and theological changes before the time of our written histories. But while the conclusions and explanations are very fascinating, they can be by no means accepted as final expressions of the exact state of things. Many archæologists who have studied the question from their point of view are not prepared to admit the conclusions. It seems as if one idea has got complete hold of Mr. St. Clair, and, like Mr. Dick and King Charles's head, it will keep on appearing at most inopportune moments. There is no doubt that observations of the sun and stars played a very important part in the worship of ancient Egypt, and that Mr. St. Clair's book is full of interesting statements made on good authority, but the best work suffers when it is evident that a preconceived notion has dictated many of the conclusions.

Aids in Practical Geology. By Prof. Grenville A. J. Cole, M.R.I.A. (Griffin & Co.) 10s. 6d. Third edition, revised and enlarged. We have examined the third edition of Prof. Cole's well-known book with great pleasure. Former editions have been a companion to all serious students of geology for more than eight years, and have been instrumental in clearing up many a difficulty and saving much valuable time. Prof. Cole is really practical. The student can turn to his book and learn where some necessary instrument can be obtained, and how much it will cost. He is given fatherly advice as to how to pack specimens, and the best way of getting them home. He is carefully conducted through the maze of petrological terminology, and has the chief morphological and other characteristics of typical fossils properly emphasized. The third edition has been thoroughly overhauled. Recent editions to the equipment of the geologist, such as the diffusion-column of Prof. Sollas, are described; also new methods of observation, like the mode of determining relative refractive indices devised by Dr. Becke. Similarly, in view of the present state of zoological classification, the palæontological sub-divisions of former editions have been somewhat relaxed. We commend this volume to all students of geology, for no one of them can afford to be without it.

* "The Mean Density of the Earth," Griffin & Co., 1894.

Elementary Practical Zoology. By Frank E. Beddard, M.A., F.R.S. (London: Longmans, Green & Co.) 2s. 6d. This book is intended as a guide to the elementary examination in zoology of the Department of Science and Art. We are rather at a loss to understand why Mr. Beddard calls his little volume "practical." A somewhat prolonged search has discovered no instructions for dissection, nor much guidance as to where the animals described can be found. For instance, the reader is informed that "the crayfish is common in many streams of this country, as well as on the Continent," and we believe no further help is offered to a student in the provinces who is anxious to obtain a crayfish and follow Mr. Beddard's description with the specimen before him. The author tacitly assumes that there is no difficulty in obtaining the types, and that dissection comes naturally to a reader of zoological narratives. But it is far otherwise in actual experience. We have known students working alone waste many valuable days searching for a vorticella or a hydra, and who have had eventually to look up advertisements and directories to find the name of a dealer where they could purchase specimens. If Mr. Beddard's book were really practical these difficulties would have been cleared up. As a theoretical book we have little but praise for the volume. The illustrations, drawn from the best sources, are clear and instructive, while the descriptions are concise and interesting.

The Groundwork of Science. By St. George Mivart, M.D., PH.D., F.R.S. (John Murray.) 6s. The author of this book lays it down that any science consists of some truths which are the results of other truths previously known, whether this primary knowledge has served as an incentive to more careful work, or as a premiss from which the newer truth has been logically inferred. These fundamental truths form the groundwork of the particular science under consideration. Every science, similarly, possesses such primitive truths, consequently, even if it consists only of a collection of all the fundamental truths of the several sciences, there must be a groundwork of science generally. But all science has been developed by the human mind, and the groundwork of science must also be sought here. The study is hence called epistemology, from two Greek words meaning a discourse on the understanding. The groundwork of science cannot be truths gained by reasoning, for such are not ultimate; nor can they depend on observation and experiment alone, for these imply the recognition of fundamental intellectual perceptions. The groundwork of science must, therefore, be composed of facts and truths which carry with them their own evidence. Such is, briefly, the object of the volume before us. The reader is taken in due course through a catalogue of the sciences and a consideration of the objects, methods, and physical, psychical, and intellectual antecedents of science. After the relations of language and science and the causes of scientific knowledge have been discussed, the nature of the groundwork of science is summarised in a final chapter. The answer to the question, "What is the groundwork of science?" is given by Dr. St. George Mivart in the following words:—"It is the work of self-conscious, material organisms, making use of the marvellous intellectual first principles which they possess in exploring all the physical and psychical phenomena of the universe, which sense, intuition, and ratiocination can anyhow reveal to them as real existences, whether actual or only possible."

From Matter to Man—a New Theory of the Universe. By A. Redcote Dewar. (Chapman and Hall.) Our author has selected a subject so vast that the sum of human knowledge is despicable in comparison therewith, and yet the fruits of his investigations in this immense field of research are compressed into less than three hundred very brief pages! One might, perhaps, give a fair idea of the manufacture of pins in the same amount of space, but to exhibit the process of making man and, more particularly, the universe with such a small expenditure in ink is either very clever or ridiculously absurd. We find that "*the bottom energy of the universe is magnetism;* every crystal, plant, animal, and man is a magnet; life is really magnetism, and thought electricity." This is the general trend of the ideas advanced. Some of the passages are very beautiful as prose poetry, but dreamy and incoherent from a scientific point of view.

Skiagraphic Atlas. By John Poland, F.R.C.S. (Smith, Elder and Co.) Illustrated. 5s. The inestimable advantages of the X-rays in future medical science will be apparent to those who peruse this atlas. Already many marvellous facts have been published relative to the disposition of the internal anatomy, fracture of bones, location of bullets in wounds, and so on, and in this book we have a series of plates showing the changes in the relative positions of the bones of the hand from the age of three to the age of seventeen—*skiagrams* of different hands. The results exhibit a most instructive view of the process of ossification as we pass from childhood towards man's estate. It is encouraging to know that workers in the Röntgen ray process have already shown in this way that previous views on the evolution of ossification must now be modified in conformity with the additional light thus brought to bear on the subject.

Earth Sculpture, or the Origin of Land-Forms. By Prof. James Geikie, LL.D., D.C.L., F.R.S. (John Murray.) 6s. This is a well illustrated volume on a fascinating subject. It may be popularly described as a book showing the incorrectness of the widespread belief in the "eternal hills" and "*terra firma.*" The land everywhere is at the mercy of never-ceasing and relentless forces of denudation. As Prof. Geikie graphically narrates, rain, frost, wind, running water, the waves, snow, and ice, all conspire together to wear away the land, obliterating existing features and sculpturing new contours. The perennial conflict between the internal forces tending to raise the crust, and the external forces to which we have referred, which by themselves would soon, speaking geologically, blot out the land, is described in the scientific and interesting manner of which Prof. Geikie is an acknowledged master. Chapter by chapter, the way in which the relation of hill and dale is affected by the arrangement of strata—whether horizontal, gently-inclined, highly-folded, or faulted—is passed under review. Altogether, to the reader with some previous acquaintance with geological terms, the book will prove stimulating and suggestive.

Whitaker's Almanack, 1899. 2s. 6d. Once again this useful work—the thirty-first annual volume—is available. A great improvement consists in the expansion of the index, an innovation which admits of about six hundred additional entries. Among new subjects introduced are the new "Employers' Liability Act," and the "National Debts of the World"; also a Municipal Directory of Scotland and Ireland. "Political Geography" has, during the past year, been considerably modified—to wit, the eating into China; the losses of Spain; and Khartum wrested from the Khalifa; and new maps are introduced into the geographical articles to indicate such changes. As illustrating the tendency in every section to expansion we may mention that there are now nearly eight hundred closely-printed pages in the present issue of the almanack.

Chemistry for Schools. By C. Haughton Gill. (Stanford.) Illustrated. 4s. 6d. A new edition—the tenth—of this popular school book is before us. Much enlarged, and in great part re-written to suit the later developments of certain branches of chemistry, it is a straightforward *résumé* of the fundamental principles of the science treated from a practical standpoint. Its past history is a sufficient guarantee that, with emendations considered needful to invest the work with a new lease of life, it will be found a reliable guide to the acquisition of a sound knowledge of the elements of chemical science. One thing, however, is not very stimulating to observe, namely, the illustrations, hoary with age and decrepit in form. Why not replace them with something in better keeping with present practice, and more agreeable to the eye?

A List of European Birds. By Heatley Noble. (R. H. Porter.) This list of the birds found in the Western Palæartic area is intended to be of use to collectors for reference and exchange of skins and eggs, and for labelling specimens. The list is really nothing more than a copy of Mr. Dresser's well-known list of 1881 brought up to date, with a supplement added containing the names of those birds of disputed occurrence. Had Mr. Dresser himself revised his list he would not have repeated, as Mr. Noble does, such mistakes as the spelling of Mistle-Thrush Missel-Thrush, or the naming of *Limosa belgica Limosa ægocephala. L. ægocephala* is undoubtedly a synonym of *L. lapponica.* The copy of the book sent to us is bound in cloth, which is an unnecessary expense if the list is to be cut up for labelling specimens.

Messrs. Bacon & Co. have sent us two charts of coloured figures, the one of British Birds, the other of Edible Birds. The charts

are mounted on cloth, and are varnished. A little book called an Object Lesson Handbook accompanies the charts. The object of the charts and the book is to help teachers to give a systematic series of lessons on British birds. Both the charts and the book are accurate, on the whole, and should prove of use. The most grievous error is the figuring of grey plover in the chart of edible birds, and the description of it on page 89 of the book. The grey plover is certainly not a typical edible bird. nor are its eggs considered a great delicacy; indeed, it is extremely doubtful if any European has ever tasted its eggs. We are told to teach, too, that "waders" are not often seen in England, whereas, of course, they may be seen in thousands on our coasts in winter. There are a few minor errors in addition to those we have pointed out. With these corrected, we think the charts and the book would be very useful; but it is naturally most important that elementary lessons such as these should be exact in every particular.

BOOKS RECEIVED.

Zoological Results based on Material from New Guinea, Loyalty Islands, etc. By Arthur Willey, D.SC. (University Press, Cambridge.) Illustrated. 12s. 6d.

Photo-Micrography. By Edmund J. Spitta. (Scientific Press, Limited.) Illustrated. 12s.

Autumnal Leaves. By Francis George Heath. (Imperial Press.) Illustrated. 7s. 6d.

Annual Report of the Smithsonian Institute, 1896.

An Intermediate Text Book of Geology. By Charles Lapworth. (Blackwood.) Illustrated. 5s.

River Development. By Prof. J. C. Russell. (Murray.) Illustrated. 6s.

A History of Astronomy. By Arthur Berry, M.A. (Murray.) Illustrated. 6s.

Recent Advances in Astronomy. By Dr. Alfred H. Fison. (Blackie.) 2s. 6d.

The Native Tribes of Central Australia. By Baldwin Spencer, M.A. (Macmillan.) Illustrated. 21s. net.

The Last Link. By Prof. Ernst Haeckel. (Black.) 2s. 6d.

Mathematical Tables. By James P. Wrapson and W. W. Haldane Gee. (Macmillan.) 1s. 6d.

The Principles of Stratigraphical Geology. By J. E. Marr, F.R.S. (University Press, Cambridge) Illustrated. 6s.

Mathematical and Physical Tables. By James P. Wrapson and W. W. Haldane Gee. (Macmillan.) 6s. 6d. net.

Results of Rain, River, and Evaporation Observations made in New South Wales, 1897. By H. C. Russell, F.R.S. (Gullick, Sydney)

A Text-book of Botany. By J. M. Lowson, M.A. (Clive) Illustrated. 6s. 6d.

Advanced Inorganic Chemistry. By G. H. Bailey and W. Briggs. (Clive.) Illustrated. 3s. 6d.

Fallowfield's Photographic Annual, 1898-9. Illustrated. 1s. 6d., post free.

The Heavens at a Glance, 1899. By Arthur Mee. (41, Hamilton Street, Cardiff.) 7d., post free.

The Studio: An Illustrated Magazine of Fine and Applied Art, January. 1s., monthly.

Through Arctic Lapland. By Cutcliffe Hyne. (Black.) Illustrated.

An Illustrated Manual of British Birds. By Howard Saunders. Second Edition, Parts 13, 14, 15. (Gurney & Jackson.) 1s. each.

Science Notes.

The recommendation by a Select Committee that the Buckland Fish Museum at South Kensington be abolished as "obsolete and dangerous, owing to the large amount of alcohol in which the fish are stored," and similar excuses for too apparent neglect, has caused great indignation among fishery boards, angling societies, and others. The late Frank Buckland, in 1881, bequeathed his museum of economic fish culture to the Director and Assistant-Directors of the South Kensington Museum, "to be for ever devoted to the use of the nation," and "five thousand pounds is to be placed in the hands of 'these trustees' as an endowment fund for a professorship." A memorial has been prepared for presentation to the Lord President of the Council protesting against the removal and distribution of the collection, and the memorial emphasizes the fact that for many years past the museum has been sadly neglected.

Sir Benjamin Stone, who gave a lecture recently at the Imperial Institute on "The Camera as Historian," has been permitted to take some interesting photographs of the Tower. One of them is "The Traitors' Gate with the Portcullis Down," showing the little door in the centre. The public of this generation have never seen the portcullis of the Tower shut down. The curious ceremonial of "Locking up the Tower at Midnight" was shown in a series of views. The chief warder is attended by a military guard, and on returning he is challenged at the main-guard with, "Who goes there?" He answers, "Keys." "Whose keys?" "Queen Victoria's keys." "Advance Queen Victoria's keys." The guard then turns out and salutes the keys. Sir Benjamin's idea is to have a permanent record of objects of interest in the daily life of the people, and the fidelity of the sensitive plate to Nature is considered invaluable as a means to this end.

A new use has been found for that well-known poison, prussic acid, or, as it is more commonly spoken of by the chemist, hydrocyanic acid. It has been recently employed in the United States to fumigate fruit trees infected with an insect called the "San José Scale" (*Aspidiotus perniciosus*). This insect attacks plum, pear, peach, cherry, and other trees, spreading over their leaves, trunk, branches and fruit, and soon completely destroys a whole orchard. The pest was discovered in California in 1879, and was, it is believed, introduced into the Eastern States in 1887 with some infected Californian trees. The ravages of the insect have extended over thirty-three States, being worst in the State of Maryland. Prof. Johnson, the well-known entomologist, has found that fumigating these trees with the gas of hydrocyanic acid has a satisfactory and beneficial effect.

The Board of Agriculture in their annual preliminary statement show that the estimated total produce of wheat, barley, and oats in Great Britain for the years 1897 and 1898 is as follows:—

	1898.		1897.		Yield per acre in Bushels.	
	Bushels.	Acreage.	Bushels.	Acreage.	1898.	1897.
Wheat ...	73,028,856	2,102,206	54.940,535	1,889,161	34·74	29·08
Barley ...	68,051,918	1,903,666	66,814,066	2,035.790	35·75	32·82
Oats	118,920,917	2,917,760	116,847,179	3,0..6,056	40·76	38·49

It is thus clear that in the case of barley and oats the acreage under cultivation during 1898 was considerably less than in 1897, and yet there is a remarkable increase in the total produce. Taken as a whole the produce of cereals this year is greater than in any year since the corn returns were first collected in 1884.

The seventh International Geographical Congress will meet in Berlin from 28th September to 4th October, 1899. All who wish to contribute communications to the Congress are requested to give notice before 1st April, 1899, and to send their manuscripts ready to print not later than 1st June, 1899, "To the Seventh International Geographical Congress, 90, Zimmerstrasse, Berlin, S.W."

An agitation is being got up to prevent the total extinction of the beaver on the River Rhone and its tributaries. Nine specimens only were killed in 1897, and the average for the last few years is but little more than this number. That beavers must have been common enough in 1855 to cause serious damage is evident from the fact that in this year the authorities responsible for the dams in connection with the Rhone offered a prize of fifteen francs for every

animal killed. This offer remained in force until 1891, when it was cancelled owing to a special appeal. The naturalists who are interesting themselves to secure the preservation of the beaver abroad from the fate which has overtaken it in this country, are wise enough to bring forward the commercial as well as the scientific side of the question. They point out that the work might be extended and careful culture on a large scale be inaugurated, seeing that not only valuable fur but castoreum is obtained from the beaver. The success of the experiments in the National Park in New York, and here in England in private grounds, might be cited as an additional inducement to carrying out similar ones on the Continent.

Obituary.

We regret to record the death of the eminent physician, Sir William Jenner, which took place on the 11th December, 1898, at Greenwood, Bishop's Waltham, at the age of eighty-three years. The son of an innkeeper at Chatham, he was educated at University College, and his first public appointment was as one of the district medical officers of the Royal Maternity Charity. In 1844 he graduated M.D., and four years later became a member of the Royal College of Physicians; in 1861 he was selected by Sir James Clarke as Physician Extraordinary to Her Majesty, and in 1862 Physician in Ordinary to Her Majesty. In 1863, he was appointed Physician in Ordinary to the Prince of Wales, and in 1864 was elected a Fellow of the Royal Society. He was created a baronet in 1868, K.C.B. in 1872, and G.C.B. in 1889, when he finally retired from practice to his country seat near Bishop's Waltham. The establishment of the essential difference between two diseases which offer many points of superficial resemblance, typhus and the so-called typhoid fever, constitutes his greatest scientific achievement. Sir William was a devoted servant to her Majesty upwards of thirty years. It may interest some to know that, on his own statement, his professional fees had amounted to £13,000 in a year.

Sir William Anderson, K.C.B., Director-General of Ordnance Factories, died on the 11th December, 1898. Born at St. Petersburg in 1835, he received his early education there, and then studied the applied sciences at King's College, London. From 1851 to 1854 he was a pupil of Sir William Fairbairn at Manchester, after which, till the year 1864, he was chiefly engaged in the construction of bridges, cranes, signals, and other appliances for railways, particularly so-called latticed girders, then but little understood. In 1889 he was appointed Director-General of Ordnance Factories, which comprise the Laboratory, Carriage Departments, and the Gun Factory at the Royal Arsenal, Woolwich, the Royal Gun Factory at Waltham Abbey, and the Small-arms Factories at Enfield and Birmingham, at a salary of £2500 a year. Sir William was the author of many works on engineering and allied subjects, his "Lectures on Hydraulics and on Hydro-Pneumatic Gun Carriages" and "The Conversion of Heat into Work" being among the best known of his publications. In 1889 he received the degree of D.C.L. of Durham University; was made a C.B. in 1895; and a Knighthood was conferred on him as a Diamond Jubilee honour.

By the death of Sir John Fowler, in November last, a conspicuous representative of modern engineering achievement is removed from our midst. Born in 1817, he became, at the age of seventeen, pupil to Mr. Leather, a hydraulic engineer, and was associated with schemes for water supply in Yorkshire. After acquiring experience of an unusually varied and practical kind, he started on his own account as chief engineer to a number of railways, notably the Sheffield and Lincolnshire and the Great Grimsby Railways. When the full fury of the railway mania broke forth, his services were eagerly sought by railway promoters. Sir John Fowler's connection with the Metropolitan Railway—a scheme discouraged by prognostications of failure from many of the most eminent engineers—has paved the way to the possible construction of those cheaper tunnelled lines which now promise to relieve the congestion which has overtaken the street traffic—for instance, the City and South London, the Waterloo and City, and the Central London Railways, with which Sir John's name has been associated. The crowning effort of Sir John's engineering skill was devoted to the construction of the Forth Bridge, which occupied six to seven years in building. On the day when the ends of the ponderous cantilever arms, stretching one thousand seven hundred feet across the waters, were to be rivetted together in the centre of the span, it was found that a gap, only an inch or two out of that vast length, was left between the severed sections of the girder, and this staggering problem was settled by kindling great fires on the bridge, the increase of temperature causing expansion, and enabled the rivets to be driven home.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE PLANET DQ.

To the Editors of KNOWLEDGE.

SIRS,—It may be of interest to supplement the article in the November number of KNOWLEDGE by giving some additional particulars which have been obtained since then. In the first place the provisional designation DQ has been replaced by the permanent number 433 and the name "Eros" (the only masculine title in the whole family of minor planets).

In the next place, the zeal of Prof. Chandler in computing accurate ephemerides, and the patience and perseverance of Prof. Pickering and Mrs. Fleming in submitting the immense storehouse of photographs obtained at Harvard and Arequipa to a searching examination, have been rewarded by the detection of the planet on twelve plates taken in 1893-94, and on four plates taken in 1896. This fortunate circumstance gives us at once the means of immensely improving our knowledge of the orbit. Perturbations will have to be computed before this can be done with strict accuracy, but, in the meantime, the following orbit deduced by Prof. Chandler may be accepted with confidence as being certainly very near the truth:—

Aphelion Passage, 1898, June 18·19, Greenwich Mean Time.

Longitude of perihelion ...	121° 9′ 53·1″	
Longitude of ascending node...	303° 31′ 57·1′	
Inclination to ecliptic... ...	10° 50′ 11·8″	
Eccentricity	0·222729	
Mean distance from sun ...	1·45810	The earth's mean distance from the sun being unity.
Least „ „ ...	1·13334	
Greatest „ „ ...	1·78286	
Average daily motion	2015·2326″	
Period	643·10 days	

It will be seen at once that these elements are very close to the original ones found by Dr. Berberich, and the difference would not be appreciable on the scale of the diagram given on p. 251, so that a new diagram is not required. It should be pointed out that there is a misprint on p. 250; Dr. Berberich's value of the period is 644·734 days, not 664·734 as printed there.

XUM

The opposition of 1894 was practically the most favourable one possible, the least distance of the planet from the Earth being only 0·153. An equally favourable opposition will not occur till 1931, or possibly longer. The opposition of 1900 is the best that we shall have till then. The following is an ephemeris for that opposition :—

	Right Ascension. h. m. s.	North Declination. ° ′	Distance from Earth.	Magnitude.
1900. Nov. 10 ...	1 56 24	54 23	0·3747	9·38
„ 18 ...	1 41 8	53 37	0·3535	—
„ 26 ...	1 30 40	51 52	0·3383	9·07
Dec. 4 ...	1 26 32	49 26	0·3268	—
„ 12 ...	1 29 22	46 23	0·3200	8·88
„ 20 ...	1 38 48	43 5	0·3162	—
„ 28 ...	1 54 28	39 39	0·3154	8·78
1901. Jan. 5 ...	2 14 34	36 12	0·3176	—
„ 13 ...	2 38 6	32 45	0·3219	8·78

The planet will have a very appreciable loss of light through phase; at times only three-fourths of its apparent diameter will be illuminated.

Arrangements are already being made for securing parallax observations at the next opposition, and it is hoped that as many as possible will co-operate in this work, so as to secure the best result attainable.

The planet is still under observation and is likely to be followed for several weeks longer. Its brightness is now pretty constant, its approach to the sun balancing its recession from the earth.

The other relations of the orbit, given last November, are scarcely affected by the new elements; the very singular fact that the planet does not retrograde when in opposition near perihelion is fully verified.

The synodic period is 2·3146 years, and the following table gives some of the multiples of this period :—

Number of Synodic Periods.	Years.	Number of Synodic Periods.	Years.
2 ...	4·6292	10 ...	23·1460
3 ...	6·9438	13 ...	30·0898
6 ...	13·8876	16 ...	37·0336
7 ...	16·2022	19 ...	43·9775
9 ...	20·8314	35 ...	81·0111
		89 ...	206·000

Hence there are three oppositions in seven years, one of which is not observable in these latitudes owing to the great south declination of the planet. Thus, after the opposition of 1900–1, the planet will not be observable in this country till 1905. In that year its position will be much the same as it was in 1898.

A. C. D. CROMMELIN.

THE SHOOTING OF RARE BIRDS.

To the Editors of KNOWLEDGE.

SIRS,—As the destruction of our rarer birds is greatly instigated by those who term themselves ornithologists and bird collectors, it may be not inopportune to address my remarks on this wanton destruction to the readers of a magazine through whose medium many interesting ornithological notes are constantly made public. In almost every issue of KNOWLEDGE we find that such and such a bird rare in such and such a neighbourhood has been shot there! Whatever reason is there for the immediate despatch of every rare bird that appears within gunshot of these collecting-maniacs or their agents? I do not say give up collections of specimens for scientific purposes, but I do say only collect them from where they can be fairly plentifully found, and where the loss of a few specimens will not mean the extinction of the whole species from that neighbourhood. Again, the excuse that if one collector does not shoot a rare bird another will is surely no reason for such conduct. For unless the minority starts by putting its principles of reform into practice never would any reform take place at all. Nor will I brand this collecting of stuffed skins (what else is it?) as intentionally or necessarily cruel, for I believe it is not, but I will say that it is antagonistic to the true interests of Nature observation—a trait which is the first essential in those who are worthy to receive the name of ornithologists. My plea for bringing this subject before the view of those who probably have had it brought before them often and often, is that only by constantly so doing can public opinion be brought to stamp out this disgrace to us as naturalists—public opinion which alone can effect any lasting change. C. E. MARTIN.

Red Hill Lodge, Compton, Wolverhampton.
6th December, 1898.

MIRA CETI.

To the Editors of KNOWLEDGE.

SIRS,—As in former years, I give a complete account of my observations of Mira Ceti.

This variable star has proved to be very interesting to the unaided eye at this apparition. Observations have been made on every possible occasion, the comparison stars used being α Ceti (2·68), γ Ceti (3·59), and α Piscium (3·99).

1898.	Mag.	Sky.
Sept. 16 & 17 ...	3·1 ...	Rather misty.
18 ...	3·1 ...	Very clear.
20 ...	3·0 ...	Moonlight.
21 ...	2·9 ...	Moonlight and misty.
Sept. 23, 25–28, Oct. 30, 2 ...	2·9 ...	Moonlight.
Oct. 11 ...	2·7 ...	Rather misty.
12 ...	2·8 ...	Extremely clear.
18 ...	3·0 ...	Extremely clear.
23 ...	3·1 ...	Rather misty.
24 ...	3·2 ...	Some fog.
26 ...	3·4 ...	Some fog.
30, 31, Nov. 1, 3	3·5 ...	Very clear; moonlight.
Nov. 5, 6 ...	3·5 ...	Misty.
Dec. 7 ...	4·3 ...	Very misty.
9 ...	4·2 ...	Very clear.

The sky was cloudy during the week in which the maximum evidently fell. The approximate date appears to have been October 6th, 1898.

70, Vincent Square, S.W., WALTER E. BESLEY.
January 2, 1899.

TREE STRUCK BY LIGHTNING.

To the Editors of KNOWLEDGE.

SIRS,—In answer to your correspondent "A. C.," I think I am right in stating that the majority of electricians would (if they felt themselves called upon to do so) candidly own that this is a matter upon which they have but little definite information. The controversy anent lightning conductors does not actually rage now, but it has by no means been brought to a conclusion.

This much, however, seems certain, the first action in such a case is electrolytic, and following that there is combustion, more or less perfect. Your correspondent is probably right in his surmise as to the cause of explosion. It may even be that some of the liquid is brought to the spheroidal state.

The point raised is one calculated to produce a wide discussion. Will the botanists who are also chemists come to our assistance?

HOWARD B. LITTLE.

23, Pembroke Road, Kensington,
London, W., 2nd January, 1899.

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PHOTOGRAPH OF THE NEBULA N.G.C. 1499 PERSEI.

By ISAAC ROBERTS, D.Sc., F.R.S.

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61 CYGNI.

To the Editors of KNOWLEDGE.

SIRS,—Dr. Herman Davis's results as regards the parallax of 61 Cygni, mentioned in your last, strike me as extremely improbable. That, if he is right, the two stars do not form a physical system may be conceded, but, it is to be added, that they do not possess common proper motions. Bring 61^2 as near to us as 61^1, and, according to Dr. Davis, the proper motion of the former will be 6·4″, and that of the latter 5·2″ per annum. But when we remember how very few stars possess as large a proper motion as either, the chance of finding two such stars (not physically connected) as close to each other as this pair would seem to be very small indeed. And in addition to this we are compelled to suppose that not only are these two stars moving in almost the same direction on the celestial sphere, but that their velocities are almost proportional to their distances from us, so as to produce an apparent common proper motion where one is really moving much faster than the other. A further coincidence is that both stars are nearly alike both in magnitude and colour. Mr. Gore has pointed out that when double stars are nearly equal in magnitude their colour is almost always the same, while if the magnitudes differ considerably the colour is different also. It is strange that such a law should be verified in a case where the equality of magnitudes merely results from the greater distance of the star that is really the brighter of the pair.

We could frame hypotheses according to which almost any of our binary stars would have no physical connection. The companion of Sirius, for example, might be much more distant than the bright star, and be revolving round a dark body, or else round a bright body which was lost in the glare of Sirius. But such hypotheses are out of place in science.

I hope an effort will be made to measure the velocity of the two stars in question in the line of sight. If they are not physically connected it will probably be different in each case; otherwise we may expect it to be nearly the same.

W. H. S. MONCK.

THE NOVEMBER METEORS IN 1898.

OBSERVATIONS of the meteoric shower of November 13th, 1897, were made at the Harvard College Observatory, and a description of the results will be found in the Annals, Vol. XLI., No. 5, and in Circular No. 31. More extensive observations were made in 1898, and the results will be published later in the Annals. Several investigations were undertaken, and some of the preliminary results are given below. As proposed in Circular No. 31, stations have been selected all round the earth in order that counts of the number of meteors visible might be made during the entire time that the earth traversed the meteor stream. The density of different portions of the stream would thus be determined. Reports from the distant stations will not be received for some time. The night of November 13th was cloudy in Cambridge, but on November 14th, eight hundred meteors, not including duplicates, were recorded at this observatory by thirty persons. The maximum occurred at three o'clock in the morning, when sixty-one meteors east of the meridian were counted in half an hour. Two hundred and twenty-seven trails of eighty different meteors, within thirty degrees of the radiant point, were charted. Similar observations were made at Providence by Prof. Upton, of the Ladd Observatory, aided by a number of students. The vicinity of the radiant was watched continuously by at least ten observers, who recorded four hundred meteors. This station is forty miles south of Cambridge, and was selected as suitable for determining the parallax visually. Ninety-six photographs were taken at Cambridge with the Draper telescopes and with eleven smaller instruments. Five photographic doublets were mounted equatorially and photographed the region within thirty degrees of the radiant, during nearly the entire night. Two cameras were carried to Tufts College, two miles north of Cambridge, and twenty-five photographs were taken simultaneously at both stations for a photographic determination of the parallax. In all, thirty-one trails of eight different meteors were photographed, of which three appeared on one plate. Four meteors were photographed at both stations, and can be used for determining the parallax photographically. The changing distance of the meteors is obvious by inspection of these photographs. A preliminary determination of the radiant was made by prolonging the trails of four meteors. They nearly intersect in a point, the greatest deviation not exceeding one millimètre, or ten minutes. The position of the radiant reduced to 1900 is thus given as R.A.= 10h. 6·8m., Dec.=+22° 16′, which is 9m. following, and 38′ south of the place given by Denning. Seventeen plates were taken with prisms, but they failed to show the spectra of any meteors. It appears from the photographs that the light of the meteors attained a maximum and then diminished as rapidly as it increased. In some cases, sudden changes due to explosions are well shown. The trail is sometimes surrounded by a sheath of light, and in one case the trail remaining after the meteor had passed was photographed. These results show that meteoric showers may now be studied to advantage by photography.

November 19th, 1898. EDWARD C. PICKERING.

PHOTOGRAPH OF THE NEBULA N. G. C. NO. 1499 PERSEI.

By ISAAC ROBERTS, D.SC., F.R.S.

THE photograph covers the region between R.A. 3h. 48m. 58·1s. and R.A. 3h. 59m. 4·2s.; declination between 35° 32·4′ and 37° 5·6′ north. Scale—one millimètre to thirty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch A.D. 1900.

Star (.) D.M. No. 792 Zone +36° R.A. 3h. 51m. 3·6s. Dec. 36° 11·9′ Mag. 7·0
„ (.) „ 805 „ +36° „ 3h. 54m. 39·2s. „ 36° 43·6′ „ 7·5

The photograph was taken with the twenty-inch reflector on 1897, December 18th, between sidereal time 2h. 44m. and 4h. 14m., with an exposure of the plate during ninety minutes.

Dr. Scheiner, in the *Astr. Nach.*, Band 132, No. 3157, pp. 203–206, gives some particulars, accompanied by a sketch, of this nebula.

Sir William Herschel, in the *Phil. Trans.* for the year 1811, notes the existence of fifty-two areas in the sky which he believed to be affected with nebulosity. Eight of those areas have already been photographed at my observatory, with the result that upon six of them no nebulosity has been found; therefore we are justified in inferring that upon these areas none exists of brighter luminosity than that of stars of the seventeenth magnitude; but upon the other two, dense nebulosity has been photographed.

The photograph annexed hereto is presented upon a scale that will enable astronomers to appreciate the extent, the structural details, and the stars down to the seventeenth magnitude that are apparently involved in the nebulosity,

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but judgment should be held in suspense until movements can be detected in the stars, or in the nebulosity, before a definite pronouncement is made that the stars are in reality involved, for the apparently finished stars may be either on the solar side of the nebula or else on the farther side, and owing to the vast distances of the stars and the nebulosity from us we cannot hope to be enabled to decide the question during our lifetime, or, indeed, that it can be decided by the next generation of astronomers, but with reliable data and sufficient interval of time between the epochs, the solution will undoubtedly be obtained.

The photograph shows the nebula to be cloud-like in character—as a thin fleecy cloud, irregular in form and in outline—with sinuous condensations of the nebulosity in several parts, in some of which are faint stellar condensations that may be the early stages in the development of new stars.

If the question should be asked: Does spectrum analysis not indicate the physical condition of this and of the other known bodies of similar appearance that exist in space? the answer would be that the nebulosities are so faint and diffuse in character as to be hopelessly beyond the light-grasping power of any form of spectroscope at present known, whether it be applied to eye observation or to the photographic plate.

The limit of the power of the spectroscope seems at present to be in the analysis of light (star-light) that is not feebler than that of stars of about the tenth magnitude. It is, therefore, evident that light so feeble as that of stars of the seventeenth or eighteenth magnitude, which may be the light of some of the nebulæ here referred to, is immensely beyond the range of the spectroscope. We must, therefore, be content in producing the best possible photographic records of the various bodies as they exist in these days, and leave our successors in the future to determine, by the correlation of their own photographs with ours, the solution of the problems which we can now only imperfectly deal with because of the absence of reliable data.

The nebula extends about 2° 36′ in length, in the direction *south following* to *north preceding*, and in breadth at the widest part about 40′.

COMPARATIVE PHOTOGRAPHIC SPECTRA* OF THE BRIGHTER STARS.

JUST a year has passed since we noticed in KNOWLEDGE the most important memoir by Miss Antonia C. Maury on the classification of the photographic spectra of six hundred and eighty-one stars. We have now to record the publication of the results of another spectrographic survey having a distinct bearing upon that of Miss Maury's.

The present research is the work of a single astronomer. Mr. McClean, whose munificent generosity to the science is well known, as shown both in his foundation of the Isaac Newton Studentships, and in the presentation to the Royal Observatory at the Cape of Good Hope of a splendid equipment for spectroscopic and photographic research, has himself carried out a complete survey of the heavens within the limits he thought well to adopt. He began the work first at his own observatory at Tunbridge Wells, using a prism of twelve inches aperture and twenty degrees angle before the object glass of his own photographic refractor. Here he fulfilled rather more than half his programme; then he completed it at the Cape Observatory, using the same prism as that which he had employed at Tunbridge Wells before the object glass of the Cape astrographic telescope. Mr. McClean's method, therefore, was essentially the same as that used in the Draper Memorial research at Harvard College. The apertures differed little—twelve inches as against eleven—the focal length was one hundred and thirty-five inches as against one hundred and fifty-three, and the dispersion Mr. McClean employed, though less than the highest used at Harvard College, was greater than the lowest. The photographs, therefore, were of the same general order, a fact which increases the value and importance of both series.

The chief differences between the two researches are as follow:—The Harvard College Survey was restricted to stars north of −30° declination. Mr. McClean's extended over the entire heavens. The former included the spectra of six hundred and eighty-one stars; the latter, extending only to magnitude $3\frac{1}{2}$, includes two hundred and seventy-six stars. The chief object of Miss Maury's discussion of her material was to systematize afresh the classification of stellar spectra and to push it to further detail; whilst the primary object with Mr. McClean was to ascertain the distribution, with respect to the Galaxy, of types which had obtained general recognition.

Having this object in view, Mr. McClean adhered practically to the simplest of all the many systems of stellar classification—that of Secchi, modifying it only by dividing the first type, that of the "hydrogen stars," into three divisions. Of these divisions Secchi had himself recognized the existence of the first, as he saw that the Orion stars differed materially in their spectra from the stars like Sirius. The Orion stars form Mr. McClean's first division, together with those of all stars that are rich in the lines of helium. The remaining spectra of Secchi's first type are grouped with Sirius in Division II., or with Procyon in Division III., according as their great hydrogen bands are more marked, or are less marked, than the great calcium band K.

The number of stars examined being small for the purposes of the enquiry, it was absolutely necessary that their classification, either according to their spectral type, or according to their position with regard to the Milky Way, should be of the simplest. The following table gives the result of the enquiry when the stars are grouped together into four equal areas, one on each side of the galactic equator, and one round each of the galactic poles:—

Stellar Types.	Galactic Regions. Upper Polar.	Upper Equatorial.	Lower Equatorial	Lower Polar.
Division I. ...	9	29	41	9
,, II. ...	13	10	6	7
,, III. ...	16	9	18	5
,, IV. ...	23	16	24	22
,, V. ...	4	5	5	5
Nebulæ.				
Planetary ...	4	10	11	2
Extended ...	2	8	11	5

Small as are the number of stars involved, the table is very suggestive. First of all it brings out clearly the preference which both the helium stars and the planetary nebulæ show for the region of the Milky Way; not an accidental similarity, since, as Mr. McClean has forcibly argued, the helium stars are probably in the earliest stage of development from the nebulæ. This disposition of early types to crowd towards the Galaxy appears a strong indication that the latter is a region where the process of the crystallization into definite world-forms of the primeval

* "Comparative Photographic Spectra of Stars to the Three and a half Magnitude" (reprinted from *The Philosophical Transactions of the Royal Society of London*), and "Spectra of Southern Stars, with Tables and Plates." By Frank McClean, F.R.S. London: Edward Stanford.

world-stuff is far from being complete. When we come to the two next divisions the evidence is conflicting; perhaps because the research deals only with the brightest stars, for the prevalence of small hydrogen stars in the Galaxy is very marked. On the other hand, Divisions IV. and V., that is to say, stars with spectra resembling those of our sun and α Herculis, appear very equally distributed. With regard to the latter, the small number of spectra concerned—only nineteen—must make us chary of putting too great weight upon the evidence their distribution affords. So far as it goes it would seem to show that the orange stars are not, as Lockyer has supposed, in an early stage of their development but in a late.

A most important result of Mr. McClean's research has been the identification of a large number of hitherto unknown lines in the spectra of β Crucis and other of the helium stars with the lines of oxygen. This identification leads him to divide the helium stars into two subdivisions —the earlier those in which the oxygen lines are marked, the later in which both the helium and the oxygen lines are dying out. This result, the establishment for the first time of the oxygen spectrum as a leading feature in celestial bodies, is of the very utmost importance, and would of itself render Mr. McClean's research remarkable. It is very significant, too, that it is in the youngest stellar spectra, and in those alone, that we find the evidence of this element the most abundant of all with which we are acquainted on our own planet.

There are several other points of interest in these two memoirs, and in the smaller papers which Mr. McClean has published in connection with the same work. First is the identification of the typical Wolf-Rayet star γ Argus as a helium star. This spectrum is one of special interest, for not only are the ordinary hydrogen absorption lines seen, but also the members of the series first discovered in ζ Puppis. The spectrum also abounds in bright bands. δ and μ Centauri are also classed as helium stars, although showing the hydrogen lines bright.

One most important feature of these two memoirs must not be overlooked. A benefit of the first order has been conferred upon students by the reproduction of the whole of the two hundred and seventy-six spectra in a series of excellent plates, Mr. McClean thus placing his readers in as nearly as possible the same position as himself with regard to them.

The entire research is a noteworthy example of the special class of work which is the distinguishing glory of English astronomy. On the Continent, astronomical progress has been usually effected at the great State observatories. The special characteristic of astronomical development in the United States has been the founding and endowment of well-equipped observatories by wealthy Americans, who have themselves taken no personal share in the work for which they provided the means. In England, the distinguishing national characteristic has been the enormous debt which astronomy has owed to amateur observers. From the days of Harriot and Horrocks, in the first dawn of telescopic astronomy; from the elder Herschel, the very father of the science in its wider, modern sense, to the days just passed of Carrington, Dawes, De La Rue, and Lassell, to Huggins, Denning, and McClean, who are still with us, the succession of noble names has been without a break. These amateurs, true lovers of their science, have, if wealthy, spent freely for its furtherance; but, whether rich or poor, have delighted to follow it up by their own exertions, their own thought and ingenuity, their own patient and laborious work.

E. WALTER MAUNDER, F.R.A.S.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

RADDE'S BUSH WARBLER (*Lusciniola schwarzi*, Radde) IN LINCOLNSHIRE.—On October 1st last I was fortunate enough to shoot an example of this species at North Cotes from a thick hedge about a quarter of a mile inland from the sea-bank. It was a most difficult bird to draw from its covert, and but for its loud and remarkable note might have been easily overlooked. The weather was fine and hot, with light south-west wind, but on the previous day there was a fresh easterly breeze.—G. H. CATON HAIGH, Grainsby Hall, Great Grimsby, Lincolnshire.

[Mr. Caton Haigh is to be sincerely congratulated on the capture which he describes above. *L. schwarzi* appears to spend the summer in South-eastern Siberia, coming as far west as Tomsk. The bird has not before been recorded within the European area. That a bird whose usual habitat is in Asia should have been captured for the first time in Europe as far west as England is very remarkable, but it is questionable if any other observer is so indefatigable and systematic in searching for strange warblers as Mr. Haigh.—H. F. W.]

LITTLE BUSTARD IN BREEDING PLUMAGE.—Early in May, 1898, a beautiful male Little Bustard, in full breeding plumage, was killed at Kessingband, near Lowestoft, Suffolk. A considerable number of these birds have been met with in Norfolk and Suffolk, but hitherto always in the colder months of the year, this being the first instance of its occurrence in summer plumage with which I am acquainted in the eastern counties.—THOS. SOUTHWELL, Norwich.

CUCKOO IN DECEMBER.—On December 4th last, a Cuckoo rose out of a rhododendron bush here, and flew by me with a following of small birds, near enough for me to observe all its markings. On the 17th I was shooting at Fulford, about four miles off, and one of the beaters told me he had seen a Cuckoo there that morning, and evidently the same bird. Though I was perfectly certain the bird I saw in the grounds here was a Cuckoo, I was glad to have my evidence corroborated. This bird was in mature plumage. —E. C. A. BYROM, Culver, Exeter, January 8th, 1899.

CUCKOOS IN WINTER IN DEVONSHIRE.—With reference to reports which have reached me of Cuckoos having been seen in this county during the present winter, it is interesting to note that Polwhele records that cuckoos were heard in January, 1776, near Mount Edgcumbe, in several parts of the South Hams of Devon, the season being extremely mild. The winter of 1775-6 can scarcely have surpassed that of 1898-9 for mildness. The mean maximum temperature of November, 1898, at Exeter, was sixty-one degrees in the open, and fifty-two degrees in the shade, and the minimum was forty degrees. All through December, also, the readings of the thermometer were remarkably high, reaching in the open seventy degrees on the 4th, and being above fifty-five degrees on twenty-nine days, whilst the minimum readings were never below thirty-one degrees until the night of the 31st, when twenty-seven degrees was reached, though the previous day was very mild. Flies were active indoors and out during the month. Primroses were in bloom in many parts of the county, ripe raspberries for sale, and wild strawberries with ripe fruit in the hedges; many summer annuals in flower in the garden, broad-leaved holly in flower towards the end of the month, and blackthorn early in January.—W. S. M. D'URBAN, Newport House, near Exeter, January 18th, 1899.

GREAT SHEARWATER (*Puffinus major*).—Mr. Bunn, of Lowestoft, sent me for inspection the fresh skin of a Great Shearwater, which had been brought in by one of the Lowestoft fishing boats about the 15th November, 1898.—THOS. SOUTHWELL, Norwich.

The Flamingo in Merionethshire (*Zoologist*, January, 1899, p. 29).—Mr. G. H. Caton Haigh shot a specimen of this bird on October 21st, 1898, on the estuary known as "Traeth-bach," in Merionethshire, North Wales. The bird had been observed in the estuary by Mr. Haigh's brother on September 28th. It was excessively wild, and proved to be in good condition, and showed no signs of having been in captivity. Only three or four examples of this southern species have previously been recorded as having visited our islands. Mr. Haigh remarks that there was a heavy gale from the south on the two days previous to the arrival of this specimen.

The Great Auk once an Irish Bird. By R. J. Ussher (*Irish Naturalist*, January, 1899, pp. 1-3).—Mr. Ussher here gives particulars of further bones discovered in County Waterford. Mr. Ussher remarks: "That my superficial searches among the sandhills, where but little of the old surface is now exposed, should have resulted in finding the remains of at least six Great Auks strewn about, suggests that these birds must have been used for food in some numbers."

Remains of the Great Auk from Whitepark Bay, County Antrim. By W. J. Knowles (*Irish Naturalist*, January, 1899, pp. 4-6).—This forms a complete list of the bones of Great Auks which have been discovered in Whitepark Bay.

The Black Grouse and the Ptarmigan formerly Irish Birds (*Irish Naturalist*, January 1899, pp. 17 and 18).—Under the title "Notes on Birds' Bones from Irish Caves," Mr. E. E. H. Barrett-Hamilton gives particulars of some bones from County Waterford which have been identified as those of the Ptarmigan and Black Grouse, neither of which species is known to have occurred in Ireland in recent times.

Hawfinch in North County Dublin (*Irish Naturalist*, January, 1899, p. 27).—Mr. J. Trumbull records the capture, on February 13th, 1898, at the Grange, Portmarnock, of a mature male Hawfinch, a rare visitor to Ireland.

Great Spotted Woodpecker in Scotland (*Annals of Scottish Natural History*, January, 1899, pp. 47-49).—A number of records appear in these pages of the immigration of Great Spotted Woodpeckers in October and November, 1898.

European Hawk-Owl in Aberdeenshire (*Annals of Scottish Natural History*, January, 1899, p. 49).—Mr. G. Sim reports that: "On 21st November an excellent female specimen of the European Hawk-Owl (*Surina ulula*) was shot by William Smith, factor on the Haddo House Estates." But one example, obtained near Amesbury, Wilts., of the European form of this bird obtained in Great Britain, has been satisfactorily identified. A bird obtained in the Shetlands, in the winter of 1860-1, was believed to be of this species.

Little Bustard in Aberdeenshire (*Annals of Scottish Natural History*, January, 1899, p. 51).—Mr. J. G. Walker, shot a Little Bustard, which is a rare visitor to Scotland, on October 24th, 1898, at St. Fergus.

Solitary Snipe near Elgin (*Annals of Scottish Natural History*, January, 1899, p. 51).—Mr. T. E. Buckley reports that a specimen of *Gallinago major*—rare in the north of Scotland—was shot on October 15th, 1898, by Mr. J. Brander-Dunbar, at Pitgaveny, near Elgin.

Fulmar Petrel breeding on Noss, Shetland (*Annals of Scottish Natural History*, January, 1899, p. 53).—Last summer Mr. Robert Godfrey found the Fulmar breeding on the Noup of Noss. This is the first breeding station observed on the eastern seaboard of Britain.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, ***at 1, Eliot Place, Blackheath, Kent.***

THE NERVOUS SYSTEM OF OUR EMPIRE.

By JOHN MILLS.

SINCE the first cable was laid between Dover and Calais in 1850, nearly two hundred thousand miles of cable have been placed beneath the sea; their united length would stretch almost to the moon, or circumscribe the globe eight times; they represent an invested capital of about fifty million pounds, ninety per cent. of which has been provided by private enterprise. Sir Sandford Fleming has evolved a practical scheme in which he advocates the adoption of a system of State-owned cables for the British Empire—all parts of the Empire to be connected together by a network of submarine cables crossing the three great oceans of the world, and nowhere coming to the surface except on British territory. The Pacific cable, the construction of which is, in Sir Sandford Fleming's opinion, the first step to be taken, would start from Vancouver and find mid-ocean stations at Fanning Island, Fiji, and Norfolk Island; at the latter island the line would bifurcate, one branch extending to New Zealand and the other to the eastern coast of Australia; telegraphic communication across the continent would put the cable in touch with King George's Sound; thence, traversing the Indian Ocean, cables would find mid-ocean stations at Cocos Island and Mauritius, extending thence to Natal or Cape Town; from Cocos Island connection would be made with Ceylon, Singapore, and Hong-kong; and from Mauritius would be in touch with Seychelles, Aden, and Bombay; the cables in the Atlantic should extend from Cape Town to Bermuda, with mid-ocean stations at St. Helena, Ascension, and Barbados; from Bermuda the telegraphic circuit of the globe would be completed by connecting Bermuda with Halifax and the existing Canadian and Trans-Atlantic lines.

One great advantage of this scheme is that each point touched would be in connection with every other point by two routes, extending in opposite directions. The total distance for which new cables would be required to carry out this grand project is estimated by Sir Sandford at twenty-three thousand knots, and the approximate cost of construction at from five million pounds to six million pounds. An incident connected with the first Atlantic cable, laid in 1858, affords a clear notion as to the utility of ocean cables in cases of emergency; the line only worked for three weeks, during which time seven hundred and thirty-two messages were sent, and the British Government countermanded by telegraph the sailing of two regiments from Canada, and by so doing effected a saving of about fifty thousand pounds. But the advantages to be derived are manifold, and extend to every department of our national life—the promotion of commerce, scientific research, and self-defence as the first maritime power of the world; indeed, the investment of our Empire with an independent nervous system, such as is proposed by Sir Sandford Fleming, would modify the existing relations of England with her colonies, and the other nations of the earth, to a degree which cannot be foreseen in its entirety in tranquil times. The existing cables are in the hands of private companies striving chiefly to earn large dividends, and who adopt the policy of charging high rates, in consequence of which trade and commerce is unduly taxed, and its free development retarded. In the early pioneer days of ocean telegraphy, the Atlantic Telegraph Company started with a minimum tariff of twenty pounds for twenty words, and one pound for each additional word, and it was not until 1872 that a regular word-rate system of four shillings per word was instituted. At the present day the rate stands at one shilling a word with all the Atlantic companies. About six million messages pass over the entire network of the world's cables in a year, or about fifteen thousand for each day of twenty-four hours.

Arguing from the data afforded by the change from a telegraph service managed by private companies to a telegraph service owned by the State and administered under the Post Office Department, Sir Sandford believes that similar public advantages will follow in the wake of cheap sea cables; thus, in 1869, the year before the Government assumed control of the inland telegraphs of the United Kingdom, less than seven million messages were carried, the cost of sending a message from London to Scotland or Ireland at that time being about six shillings. At the transfer, in 1870, the rate was reduced to one shilling per message, and the traffic immediately

doubled. After the first decade, in 1880, twenty-nine million messages were transmitted, with a surplus revenue of three hundred and fifty-four thousand and sixty pounds. In 1890, although the charge had previously been reduced from one shilling to sixpence, the annual business equalled ninety-four million messages, the operations still resulting in a surplus of two hundred and fifty-one thousand eight hundred and six pounds. With reference to the messages between London and Australia, in 1890, when the charge was nine shillings and fourpence per word, the gross business consisted of eight hundred and twenty-seven thousand two hundred and seventy-eight words, with a revenue of three hundred and thirty-one thousand four hundred and sixty-eight pounds; while in 1897, when the charge was reduced to four shillings and ninepence per word, the business increased to two million three hundred and forty-nine thousand nine hundred and one words, with a revenue of five hundred and sixty-seven thousand eight hundred and fifty-two pounds, or two hundred and thirty-six thousand three hundred and eighty-four pounds in excess of 1890, when the highest rates were exacted. Now, "were the cables owned by the State, large profits would not be the main object, and, precisely as in the case of the land lines of the United Kingdom, it would be possible to reduce charges so as to remove restrictions on trade and bring the service within reach of many now debarred from using it."

Further development of the already vast nervous system of our planet will be attended with beneficent results to science. Could anyone have dreamt that the discoveries of Galvani, who, having hung on an iron railing the legs of a frog fastened to copper hooks, observed that each gust of wind caused convulsions in the legs of the dead animal—who, one may ask, could have prophesied that this apparently insignificant observation would entirely alter the character of a future century? and yet it is but an application of this discovery, extended, it is true, by many intermediate researches, that annihilates space and time; that empowers our thought to travel with the speed and with the power of lightning to the most distant land, and enables mind to be reciprocated without being arrested by distance in space. Continents are thus joined, in spite of intervening seas, and, by rendering sudden invasion all but impossible, more security is given to nations than cordons of soldiers or fleets at sea could bestow. To the astronomer these cables are invaluable as a means of recording the transits of stars at places widely separated, and thus determining accurately the distance apart in longitude. In a mercantile aspect, the telegraph produces consequences no less individually important than its general results, such as when it sends information to distant provinces of the approach of a tornado, time being thus given to provide against the fury of the storm. In the last annual report of the Meteorological Council, it is shown, in this connection, that during the last twelve months fifty-five per cent. of their forecasts were correct, twenty-six were nearly so, six were failures, and thirteen partially so. This branch of scientific work is becoming more and more accurate as observing stations increase, and the scheme proposed by Sir Sandford Fleming would probably augment its utility to an extent which at present it is impossible to forecast. The more cables there are, and the more they are under our own control and protection, the greater will be the freedom of action among the many members of our otherwise unwieldly empire; a leg, an arm, or other appendage, will acquire a quickening impulse which will enable each and all to respond more promptly to the guiding genius at home entrusted with the direction of the affairs of State.

THE ICKNIELD WAY IN NORFOLK AND SUFFOLK.

By W. G. CLARKE.

THE landmarks of even a century ago are now many of them unknown. We cannot, therefore, wonder that the British trackways in use prior to the Roman occupation have, in many cases, become merely names—their courses unknown to the antiquary. One of the longest and most interesting of these trackways is the Icknield Way, which, originally British, was adopted and improved by the Romans. For the greater part of its course it is still used as a highway. In Anglo-Saxon charters it is termed the *Icenhilde Weg*—*i.e.*, the war path of the Iceni. In the time of Edward the Confessor, this road was one of the *Quatuor Chimini*, differing from the other three in apparently never having been re-made by the Romans. In the neighbourhood of Ashdown it is described as "a broad, grassy road, marked off from the surrounding fields by low banks, and called, in that part of the country, the 'Green Road.'"

The course of the Icknield Way from Dorchester to Royston, on the borders of Cambridgeshire, is generally well-known. It seldom leaves the dry and open chalk, and is guarded by a remarkable series of hill forts, peculiar, both in form and position. The villages of *Ickle*ton and *Ickle*ford are not far distant from the accepted route. At Royston, it crosses the Ermine Street almost in the centre of the town; and near the four crossways is a remarkable cave in the chalk, originally a British habitation, formed by means of shafts.

Mr. Arthur Taylor, F.S.A., added another link to the chain of evidence in a paper read before the Archæological Institute at their Norwich meeting in 1847, fixing Newmarket as the next important point. In a deed, *tempus* Henry III., in Mr. Taylor's possession, conveyance was made of a sollar with houses and chambers upon *Ykenildeweie*. This property was situate in High Street, Newmarket. Between Royston and Newmarket, the road crosses the *Via Devana*, the Brand Ditch, the Fleam Dyke, and the Devil's Dyke, and is flanked by the Pampisford Ditch.

After leaving Newmarket, Mr. Taylor favoured a route leading through Icklingham and Thetford to Norwich Castle Hill, but insufficient local knowledge precluded a detailed description. The greater part of the present main road between Newmarket and Attleborough, passing through Thetford, is of comparatively recent construction, probably having been made subsequent to 1695. The unmade road in use prior to that time was in all probability originally the Icknield Way. That this ran through Icklingham seems indisputable.

After leaving Newmarket, the road appears for a time as the county boundary between Suffolk and Cambridge, crossing the Kennet, a tributary of the Lark, at Kentford, and over that river itself at Lackford. The portion between Kentford and Cavenham is marked as "The Icknield Way" on the Geological Survey map. From Icklingham All Saints to Thetford, the Icknield Way follows the boundary line of the hundreds of Blackbourn and Lackford—the ford of the Lark—evidently considered one of the most striking features in the hundred. It is also probable that Blackbourn hundred was so named from Blackwater, the great ford near Rushford, where Peddar's Way crossed the Little Ouse. In those days it was of primary importance to make for the best river fords.

From Icklingham the road is well marked, although practically never used. This place-name, as with others on the Way, is derived from Ick, a British tribal name Latinized into Iceniling—*i.e.*, home of Icklings, children of

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Ick (Coulton). Numerous Roman remains have here been found in Rampart Field, where earthworks formerly guarded the ford of the Lark. There are several tumuli near the Way, between Newmarket and Thetford, and both Paleolithic and Neolithic flint implements have been found in abundance. "Old Elveden Gap" was so called to distinguish it from its newer companion on the turnpike road. These gaps were, originally, cuttings through the forest. The Icknield Way crossed the present road between Barnham and Elveden, at a spot known as Marmansgrave, where it may yet be seen in all its pristine glory—although rarely used. A suicide was here interred, showing that at one time the four crossways were of equal renown, although there are more typical ones in the parish now. This road was used less than one hundred years ago for driving cattle to the London market.

From Marmansgrave (Elveden), Suffolk, to Larlingford, Norfolk, the course of the Icknield Way is not so clear. Some of the banking may yet be seen at the rear of Thetford Cemetery. The Icknield Way crossed the high road between Bury St. Edmunds and Thetford, a few yards north of Thetford Gasworks. In one of Gall & Inglis' recent maps of Suffolk this road is shown, and up to a short time ago its course could be accurately traced. It is well marked in a map of 1749. In the field where the gasworks are situate, remains of a populous British settlement were found in 1870, including pottery, bone awls, stone and bone amulets and remains of habitations. Similar remains have been found in a field on the opposite side of the road, also crossed by the Icknield Way. Three roads still remain at "Chunk Harvey's Grave," where another excommunicate was buried, and the Icknield Way formed the fourth. This obliterated trackway is still supposed to form the boundary between the hundreds of Blackbourn and Lackford. A short distance further the road turns abruptly at right angles over the river Little Ouse, a most pronounced characteristic of British track-

FIG. 1.—"Chunk Harvey's Grave," Thetford. The Icknield Way ran from (A) to (B).

ways. This was in most cases to find an easier passage. Within a hundred yards the road crosses the Little Ouse, a rivulet, and then the Thet, the bridges being termed the "Nuns' Bridges." Blomefield describes the Castle Hill, Thetford, as being "close by that ford or most frequented passage over the river, from whence the city had its name." The derivation, however, is by no means certain. If the terminal be taken as the Anglo-Saxon *ford*, it undoubtedly

FIG. 2.—Bridge over the Thet at Thetford. Anciently the ford of the Icknield Way.

refers to this one. It is possible, though not probable, that the terminal is the Celtic *fford*, a road or trackway, relating to its position on the Icknield Way, as in ancient documents the place-name not infrequently occurs as Thefford. The prefix may be from the word Theod, a contraction of some personal name as Theodosius (Coulton). The most probable derivation seems to be from the Anglo-Saxon, Theote, a broken stream. In that case, Thetford would mean "the ford of the broken stream." In the Autobiography of Roger North, Attorney-General to James II. ("Lives of the Norths," Vol. III., pp. 10 and 11), he says: "There was a navigable river in the town (Thetford) which, above the bridge, branched into many brooks and scattered streams."

It is remarkable that not until 1697, or two years after the presumed construction of the highway between Thetford and Newmarket, is the erection of the Town Bridge, Thetford, by which the present highway crosses the river, mentioned. Reference to the repair of the Nuns' Bridges occurs in 1539, in a deed between the Prior of the Monastery of Our Ladye of Thetford, and Richard Cockerell, Mayor of the borough. Mention is also made of land abutting on "Lackefordeweye," which must necessarily have been the road through Icklingham.

From the River Thet, the logical and undoubtedly correct continuation of the Icknield Way is by the Castle Lane and Green Lane, Thetford. In the former, the road passed close by, if not through, the boundaries of the wonderful British earthworks known as Thetford Castle Hill, which Mr. Mark Knights, in "Peeps at the Past," termed the "most remarkable artificial earthwork in East Anglia." At the southern end of Green Lane, there were found in 1870, in a field adjoining the Icknield Way, Roman and Celtic pottery, an unground axe, and various implements of flint. Eight of Thetford's mediæval churches—of which three at least were Saxon—abutted on this portion of the Icknield Way, and several monastic establishments were in close proximity. Up to the beginning of the present century one of the streets uniting with the Icknield Way was termed Heathenman

Street, pointing across a thousand years to the march of the "heathen men" (Danes) of the Anglo-Saxon Chronicles.

In Robert Morden's map of Norfolk, in 1695, the present Norwich turnpike between Thetford and Larlingford is not marked. There is the road to Croxton, but the Norwich highway crosses the river at Nun's Bridge, and runs north-eastward by way of Castle Lane and Green Lane, and further by a road which can now be but imperfectly traced. The present high road and Magdalen Street are shown as lanes, between the Croxton and the then Norwich turnpikes. In 1749 the present road was

Fig. 3.—The Green Lane, near Thetford, showing the Icknield Way as an unmade track, banked on either side.

shown on a map of the county in addition to the old one. This was the case in 1777, but in 1808 the old road is omitted, and the same in Laurie and Whittle's map of Norfolk and Suffolk in 1811. However, in a map by Mr. Thomas Dix, presumably early in the present century, a continuation of the Green Lane is shown running parallel with the present highway until uniting with Peddar's Way. This road is also shown on one of Gall and Inglis' most recent maps of Norfolk, although Green Lane is omitted. From the northern end of Green Lane to its junction with the present Thetford-Norwich highway, presumably to the south-west of Larlingford, it is a matter of some difficulty to trace the course of the Icknield Way. In one of the fields between Green Lane and Roudham Heath, five hawthorns would seem to indicate the ancient track, which is continued by three in the next. On the heathland itself the road can be imperfectly traced by the old banks, chiefly in the near neighbourhood of that well-known British track, the Peddar's Way, which it crosses about half a mile from where the Peddar's Way is joined by the Drove, another British way leading from the fenland. So overgrown is the Icknield Way by ling and bracken, during the two hundred years that it has been superseded by the present turnpike, that it is difficult to dogmatise as to its exact course hereabouts. A Bridgham tradition makes mention of a waggon-road which formerly ran over Roudham Heath. This undoubtedly refers to the Icknield Way. In May, 1010, the great battle of Ringmere, in which Sweyn the Dane defeated Ulfketel the Saxon, was fought on this heath. There was undoubtedly a British trackway between Thetford and Norwich, connected with the British town of Attleburgh, and passing a tumulus at Cringleford. There was also a British settlement at Wymondham, and near the Way was the great camp at Buckenham. That Norwich Castle Hill was one of the most noted British earthworks in East Anglia is undisputed, and its connection with the Icknield Way has long been a matter of presumption. Between Thetford and Norwich the road crosses the Thet, at Larlingford, a name given in later days, but when fords were still an important feature in travelling; and the Yare at Cringleford (from the O.N. Kringla, a curve, the river here bending in the form of a horse-shoe). Relics of life in early Britain have been found not infrequently on the line of route between Thetford and Norwich. In 1845 a quantity of bronze weapons were found in a village near Attleborough. Five axes of flint were also found by the side of the river at Hargham, and similar instruments have been found at Attleborough, as well as a small disc of baked clay, about one-sixth of an inch thick and three inches in diameter (Roman).

From the preceding portion of its course one can reasonably conclude that the route between Norwich Castle Hill (chalk) and the sea, would also follow the chalk formation. Mr. Arthur Taylor favoured a route near Hickling, without further particularizing its course, but the most reasonable and logical way seems to be by Sprowston, Rackheath, Wroxham, Hoveton, Beeston St. Lawrence, Smallburgh, Stalham, and Happisburgh—a route which keeps to the chalk and avoids the marshland of the Broad district, which in pre-Roman times was undoubtedly almost wholly under water. In support of this it may be mentioned that Hoveton is derived from the Old Norse Hof, a temple, presumably showing a settlement here prior to Roman times (*vide* "Rye's History of Norfolk"); Smallburgh was probably a small Roman outpost. Near Stalham is a mound and ditch known as the "Devil's Ditch," which are most certainly artificial, and are probably British earthworks. They are situated about a quarter of a mile from the highway, and would guard the *Wayford*, the "ford of the way" over the River Ant, a continuation of the series of earthworks guarding fords, as Rampart Field at Lackford, and the Castle Hill at Thetford. About twenty years ago a splendid British shield was dug up in the marshland at Sutton, and Cotman narrates the discovery of flint implements at Ingham. Mr. W. H. Cooke, of Stalham, thinks the road from that place to Happisburgh the most probable continuation of the Icknield Way. Happisburgh was a Roman station, and was thought by Mr. Rye to be the southern termination of the coast road to Brancaster.

For assistance in philology, I must record my indebtedness to Mr. J. J. Coulton, of Pentney, Norfolk; and for local information to Messrs. G. Gathercole, of Thetford, and Mr. W. H. Cooke, of Stalham. The illustrations are from photographs specially taken by Mr. R. A. Howard, of Thetford.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

A solution of formaldehyde containing one part in from one hundred to one hundred and fifty parts of water makes an admirable medium for hardening tissues. The longer the tissues are left in it the better are the results.

The glare which is usually associated with low powers and a bull's-eye condenser may be modified and diffused by laying the slide containing the object on a slip of ground glass. This device not only eliminates the flare, but it also renders the work of observation much less tiring to the eyes.

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Glycerine is one of the most useful preservative media for microscopical manipulations. Pure glycerine should not, however, be used, as confervoid growths are apt to appear in it. To obviate this, the addition of about two per cent. of camphor water is recommended.

In a paper read at the last meeting of the American Microscopical Society, Mr. B. D. Myers embodied the results of a series of experiments that he has conducted in the histologic laboratory of Cornell University on the uses of picro-carmine and alum carmine as counter stains. With hematoxylin the picro-carmine gives a more differential stain than picro-fuschin, and shows the characteristic alkaline re-action with hematoxylin, bringing out the hematoxylin as a beautiful sharp blue, while the acid picro-fuschin tends to fade it.

The Canada balsam of commerce is frequently contaminated with impurities, and is therefore not always suitable for mounting purposes. These impurities may be eliminated by filtration in the following manner:—Make a cone of Swedish filter paper, and affix to the outside of it, at equal distances apart, three short lengths of glass tubing. On placing this apparatus in a glass funnel of suitable size, the tubing will prevent the filter paper touching the sides of the funnel. Dissolve the balsam, which is to be treated, in sufficient benzole to make a mixture of a thin, syrupy consistency. Pour this into the filter, and to prevent evaporation cover the funnel with a greased glass plate. The filtered balsam should be put on one side until the benzole has evaporated sufficiently to allow of its being used.

To preserve microscopic organisms intact, it is necessary that they should be mounted without crushing, flattening, bleaching, or contorting their parts—that is, the organisms should, after the preliminary stages of preparation, be mounted in a medium of suitable density, and "without pressure." The following medium—viz., absolute alcohol, three parts; glycerine, two parts; and distilled water, one part—will be found to give very successful results with hard ova, zoœa, the young of crustacea, and most insects and plants. The specimens, which should be quite fresh, ought to be dropped into small tubes containing the above mixture, and allowed to remain there for any period varying from three to twelve months. Should the fluid become discoloured, decant it, and replace with a fresh supply. When ready, the specimens must be placed in a cell containing the fluid in which it is intended they shall be mounted. The composition of this may be six parts of distilled water and one part each of glycerine and alcohol, or such other proportions of these constituents as may be best suited to the object to be mounted, provided that the density of the mountant be *less* than that of the fluid which was used in the preparatory stages. This method of preparation has been successfully tested in marine biological laboratories both at home and abroad.

Microscopists, who have occasion to do much work with the camera-lucida, will find the following device of considerable assistance in their microscopical sketches:—Take a circular cover glass, rule it in squares, and drop it in the eye-piece so that the squares may be seen crossing the field of view in which the object has been placed. By carefully transferring to squared paper the observations obtained, a satisfactory and effective drawing of the object may be made. Mr. G. C. Karop suggested to the members of the Quekett Club the following method for etching the squares on the glass cover glass:—Cement the circle to a glass-slip, cover it with a thin coating of paraffin wax, and rule the squares required with a fine-pointed needle. Mix a small quantity of finely-powdered fluor-spar and concentrated sulphuric acid in a platinum crucible, heat the mixture, and allow the resulting fumes of hydrofluoric acid to play on the squares of the glass circle. The etching will soon be effected, after which, clean the glass and mount it in a circle of cardboard.

Bujwid was the first microscopist to systematically study the germ life contained in hailstones. The subject has now been taken up by Mr. C. F. Harrison, of Guelph, who has isolated and determined a series of bacteria and moulds, two of which, *B. flavus grandinis*, and *M. melleus grandinis*, are new to science. He has published a monograph on the subject, in the course of which he describes the methods that he adopted. The hailstones were washed in a mercuric chloride solution (one in five hundred), rinsed several times in sterilized cold water, and each stone thus treated was dropped into a tube of melted nutrient gelatine. The mixture was then thoroughly shaken, and the plates made in the usual manner. Four days afterwards the plates were counted, all the bacteria and moulds were isolated, and their cultural characteristics determined. The results have led him to support Bujwid's theory, that surface water is carried up by storms and frozen, producing hailstones.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Brooks's Comet (discovered October 20th) is now invisible to observers in this country. At the middle of February the comet will be situated in Corona Australis, and very faint, for its distance from the earth will be about one hundred and ninety millions of miles.

Chase's Comet is favourably placed as regards its position in the heavens, but is too difficult an object to be seen in ordinary telescopes. The following is an ephemeris for Berlin midnight, by Möller (*Ast. Nach.*, 3531):—

Date.	R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.	Brightness.
February 4 ...	11	7	48	+35	1	174	1·02
,, 8 ...	11	6	23	35	40	175	0·99
,, 12 ...	11	4	42	36	15	176	0·96
,, 16 ...	11	2	47	36	47	178	0·92

The comet is therefore receding from the earth and gradually becoming fainter.

Periodical Comets due in 1899.—A considerable number of these interesting bodies are expected to return to perihelion during the present year. Denning's Comet (1881 V.) is due in February. Tempel's Comet (1866 I.), which deserves particular notice from the fact of its close association with the Leonid meteors, should return in the spring. Barnard's comet (1892 V.), Tuttle's (1858 I.), and Holmes's (1892 III.) is expected in April or May, while Tempel's comet (1873 II.) should be seen in July. The latter comet ought to be well displayed at this return, for the conditions are nearly the same as in 1873 (five of its periods of 5·20 years being equal to twenty-six years), when the comet was on the same side of the sun as the earth.

The Leonid Meteors.—Reports of observations continue to come in, but some time must yet elapse before a complete summary of all the results can be compiled. American observers appear to have been the most successful, but a really brilliant shower was not observed anywhere. Prof. Payne, at Northfield, Min., watched on November 14th, 12h. 30m. to 15h. 45m., and counted eighty-one meteors, nearly all of which were Leonids. Mr. H. R. Smith, at Philadelphia, counted seventy-six meteors between 12h. 20m. and 16h. 40m. on the same night. Prof. Landis, at Carlisle, Pa., reports that on November 14th, between 12h. and 13h., thirty-four meteors were counted; between 13h. and 14h., sixty-four; and between 14h. and 14h. 30m., fifty-four. Four to twelve observers were engaged, and he judged that the average hourly number from one hundred to one hundred and twenty-five. At Northfield, Min., two meteor trails were photographed. Prof. Wilson describes them as perfectly straight, and lines drawn through the two intersect at 151·5° + 22·3°. This is in remarkable agreement with the place of the radiant as determined by four trails photographed at Harvard College, which nearly intersected at the point R.A. 10h. 6·8m. Dec. +22° 16′. This accordance encourages the hope that, though the recent shower was less brilliant than expected, photography has fully justified its employment, and furnished us with the place of the apparent radiant with a high degree of accuracy. He says, in summarizing the American observations, that on the morning of November 15th the probable horary rate of Leonids for one observer watching the sky continuously was about forty. This shows a great increase of strength as compared with 1896 and 1897, but the most singular result is that the radiant was found to be nearly two degrees south of the average position (149° 28′ + 22° 52′) indicated by observations during the previous sixty-five years.

At the Yerkes Observatory, Prof. Barnard had a clear sky shortly after midnight on November 14th, and watched until daylight. He saw several hundred meteors, many of them being of the first magnitude, and a few brighter. They left bluish-green streaks. The maximum was reached between 3 a.m. and

4 a.m. (10 a.m. G.M.T.), and perhaps nearer 4 a.m. He had five cameras pointed to different parts of the sky, but at the time of writing had found no trails on the plates he had developed. At the Observatory at Harvard College it appears, however, that Prof. Pickering secured a considerable number of photographic trails. He and his observational staff saw an aggregate of eight hundred meteors.

At Burgess Hill, Sussex, the sky was clear on November 13th, and Mr. Gregg reports in the *English Mechanic* that he watched —between 11h. 50m. and 18h. 10m.—and counted sixty-four meteors, of which forty-three were Leonids.

The Geminid Meteors.—These were tolerably numerous in 1898. On December 12th, 7h. 25m. to 11h., Mr. R. Service, of Dumfries, counted fifty-two meteors. Between 9h. 30m. and 12h. 30m., Mr. A. King, at Leicester, saw forty-one. Mr. Nielsen, at Hartlepool, observing from the cliff between 9h. 5m. and 10h. 5m., counted thirty-six meteors, of which thirty-five were Geminids. A number of meteors were also observed by Mr. Besley, Mr. Milligan, and others. The former found radiants at 104° + 31′ and 115° + 32′.

THE FACE OF THE SKY FOR FEBRUARY.

By A. Fowler, f.r.a.s.

The Sun.—On the **1st** the Sun rises at 7.41 a.m., and sets at 4.47 p.m.; on the **28th** he rises at 6.50 a.m., and sets at 5.36 p.m.

The zodiacal light may be looked for in the west after sunset.

The Moon.—The Moon will enter her last quarter on the **3rd**, at 5.24 p.m.; will be new on the **10th** at 9.32 a.m.; enter her first quarter on the **17th**, at 8.52 a.m.; and will be full on the **25th**, at 2.16 p.m. 19 Piscium (mag. 5·2) will be occulted on the **12th**, the disappearance taking place at 7.35 p.m., 78° from the north point (39° from the vertex); at the reappearance, fifty-three minutes later, the star will be setting. 103 Tauri (mag. 5·5) will be occulted on the **18th**; the disappearance will take place at 8.53 p.m., 96° from the north point (66° from the vertex); and the reappearance at 10.11 p.m., 273° from the north point (233° from the vertex).

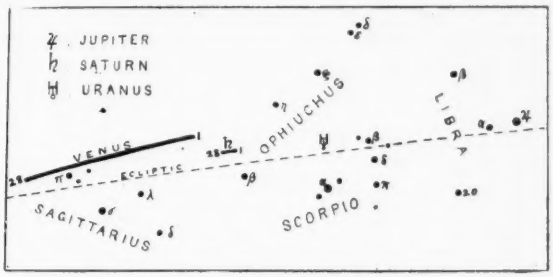
The Planets.—Mercury is not well placed for observation during this month. He is a morning star at the beginning of the month, reaching superior conjunction on the **27th**.

Venus is now a brilliant object in the morning sky. She reaches her greatest western elongation of nearly 47° on the **11th** at 7 a.m. During the month her apparent diameter diminishes from 28″ to 21·8″. At the middle of the month about half the disc will be illuminated. The path of the planet lies in Sagittarius. She rises about three hours before the Sun at the beginning, and about 2h. 40m. before the Sun at the end, of the month.

Mars will be readily recognized in Gemini, through which he traverses a retrograde path until the **27th**, when he will be stationary. He will be visible, practically, throughout the night, crossing the meridian at 10.57 on the **1st** and at 8.53 on the **28th**. The apparent diameter of the planet diminishes from 13·8″ to 11·2″ during the month, and his distance increases from about sixty-two million eight hundred and seventy-nine thousand to seventy-seven million eight hundred and fifty thousand miles.* The phase will be very slight, the illuminated part on the 14th being 0·969 of the disc.

Jupiter is becoming more favourably situated, rising at midnight about the middle of the month, and about 11 p.m. at the end. He is near α Libræ, and will be stationary on the **24th**, his path accordingly being a very short one. His polar diameter increases from 34·4″ to 37·4″ during the month.

Saturn is a morning star, rising about 4.30 a.m. on the **1st**, and shortly before 3 a.m. on the **28th**. He traverses



The Morning Planets in February.

a short direct path in the most southerly part of Ophiuchus. The northern surface of the ring is visible, and the rings are widely open.

Uranus is also a morning star near ω Ophiuchi. He will be in quadrature with the Sun on the **26th**.

Neptune is visible nearly all night. At the middle of the month he precedes ζ Tauri by 6m., and has a declination 49′ greater than that star.

The Stars.—At the beginning of the month, Gemini and Canis Minor will be on the meridian shortly before midnight, Canis Major a little after 10 p.m., Orion about 9 p.m., and Taurus soon after 8 p.m. At the end of each succeeding week these constellations will be in the south about half an hour earlier.

Conveniently observable minima of Algol will occur on the **11th** at 10.39 p.m.; and on the **14th** at 7.28 p.m.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of January Problems.

No. 1.

(By W. Clugston.)

1. Q to B7, and mates next move.

No. 2.

(By C. D. Locock.)

[The composer's intention was 1. B to Kt3. Unfortunately 1. P to Q3 instead solves the problem, while it prevents the main variation.]

Correct Solutions of both problems received from Alpha, K. W., H. Le Jeune, D. R. Fotheringham, N. E. Meares, F. V. Louis, G. C. (Teddington).

Of No. 1 only, from W. H. Stead, G. G. Beazley.

Of No. 2 only, from H. S. Brandreth, A. W. Webb, W. de P. Crousaz, A. Gorham, Miss Theakston.

H. S. Brandreth.—In No. 1, if QKt7, B or P moves.

Miss Theakston.—1. R × P is met by 1. B to Kt5 or R6.

A. Gorham.—The King escapes at K6.

W. de P. Crousaz.—If 1. Kt to Q3, B to Kt5 or R6.

H. Bristow.—Thanks for the problem. Would it not be possible to get rid of a few of the pieces, even at the cost of one variation if necessary?

* The distance at opposition in January was about 60 millions of miles, not 143 millions, as incorrectly stated in the January number. —A. F.

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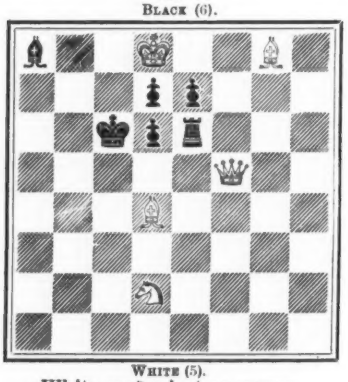
PROBLEMS.

By J. Nield, Crompton.

No. 1.

BLACK (6).

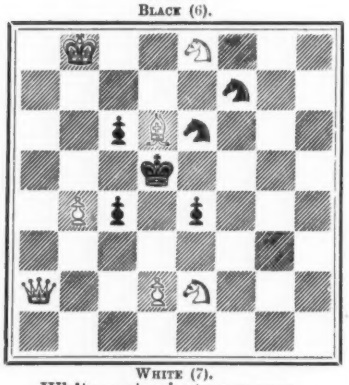


WHITE (5).

White mates in two moves.

No. 2.

BLACK (6).



WHITE (7).

White mates in two moves.

CHESS INTELLIGENCE.

The annual amateur tournament at Craigside, Llandudno, took place as usual during the first week in January, with the following result:—

First Prize	...	A. Burn	9
Second ,,	...	H. E. Atkins	7½
Third ,,	...	G. E. H. Bellingham	6
Fourth ,,	...	G. A. Schott	

The other competitors were Messrs. Gunston, Owen, E. O. Jones, Wilmot, Dawbarn, Wahltuch, Thrift, and Dod. Last year it will be remembered that Mr. Burn was also the winner; Mr. Bellingham on that occasion was a good second, but seemed a little out of form during the present tournament.

The match between Messrs. Janowski and Showalter has been adjourned during the Christmas holidays and now resumed. The present score is Janowski, 4; Showalter, 2; drawn, 3.

The match between Sussex and Hants in the Southern Counties Chess Union competition resulted in a draw, the score being ten games to each side.

The game below was played in the recent Craigside Tourney.

"Four Knights' Game."

WHITE. (V. L. Wahltuch, Manchester.)	BLACK. (H. E. Atkins, Leicester.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. Kt to QB3	3. Kt to KB3
4. B to QKt5	4. B to QKt5
5. Castles	5. Castles
6. Kt to Q5 (*a*)	6. Kt × Kt
7. P × Kt	7. P to K5
8. P × Kt (*b*)	8. QP × P
9. B × P (*c*)	9. P × B
10. Kt to K1	10. P to KB4 (*d*)
11. P to QB3	11. B to Q3
12. P to KB4	12. B to R3
13. P to Q3	13. P × P
14. R to B3	14. B to B4ch
15. B to K3	15. Q to K2
16. B × B	16. Q × Bch
17. K to R1	17. QR to Q1
18. Q to Q2	18. KR to K1
19. R to B2	19. R to Q4 (*e*)
20. Kt to B3	20. R to K7
21. R × R	21. P × R
22. Kt to Q4	22. Q to K2
23. Q to K1	23. P to B4
24. Kt × B2 (*f*)	24. Q to K5
25. Kt to R3	25. B to Kt2
26. Resigns.	

NOTES.

(*a*) Since the discovery of 7. . . P to K5 for Black this move has fallen into discredit.

(*b*) 8. Kt to Ksq is probably better.

(*c*) Though this capture isolates Black's Queen's side Pawns, he has ample compensation in the freedom of his two Bishops and Rooks.

(*d*) Black can apparently win a Pawn at once by BR3, followed by B × Kt, but he is reluctant to part with his most valuable Bishop for an inactive Knight. As it is, White's position is already almost hopeless.

(*e*) In order that the Rook may be defended after the subsequent captures.

(*f*) This is fatal. 24. Kt to B3 would prolong the game.

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